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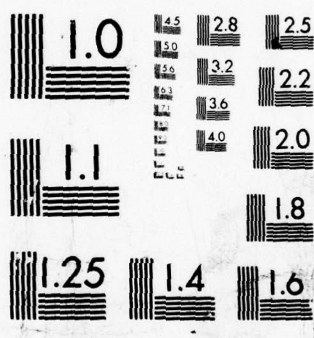

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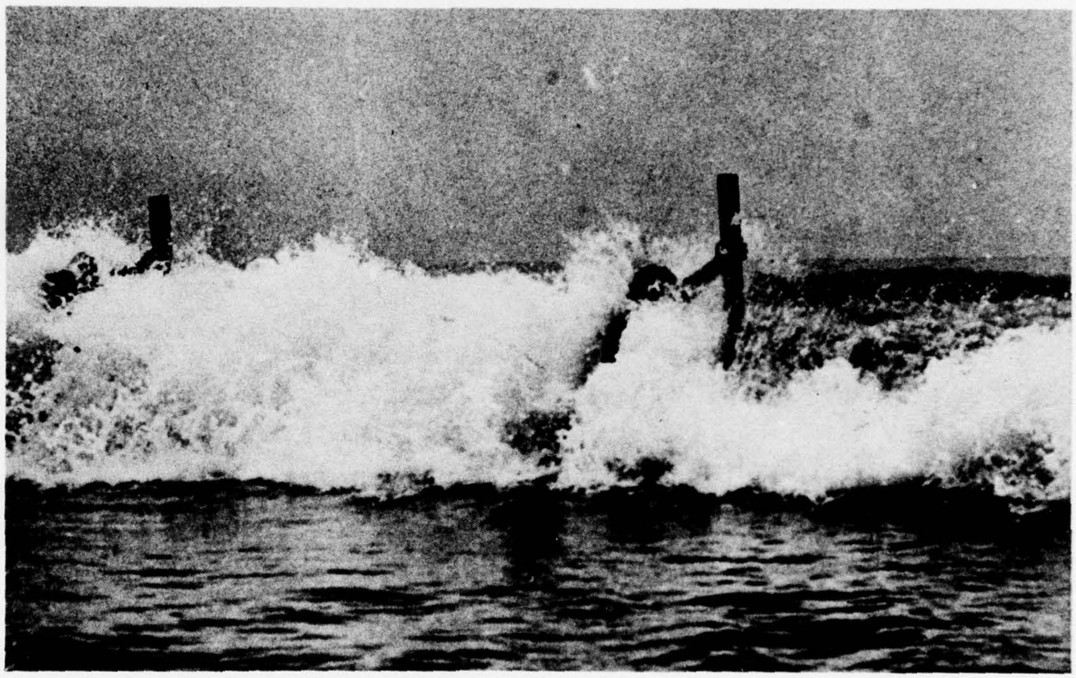
Technical Report No. 18–CRD

SUSPENDED SEDIMENT IN BREAKING WAVES

Timothy W. Kana



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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 19 16132.1-GS 18 ARO	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 Suspended Sediment in Breaking Waves		5. TYPE OF REPORT & PERIOD COVERED 9 Technical rept. 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 Timothy W. Kana		8. CONTRACT OR GRANT NUMBER(s) 15 DAAG29-79-G-0011, DAAG29-76-G-0111
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of South Carolina Columbia, South Carolina 29208		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Research Office P. O. Box 12211 Research Triangle Park, NC 27709		12. REPORT DATE 11 Apr 79 13. NUMBER OF PAGES 153
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 162p.		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

408 014

411 049

LEVEL II

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DDC
AUG 24 1979

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

14 TR-18-CRD

18. SUPPLEMENTARY NOTES

The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

surf zones
sedimentation
suspended sediment
breaking waves
breaker zone
beaches

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Suspended sediment concentration was measured in 235 breaking waves on undeveloped beaches near Price Inlet, South Carolina, U.S.A., using portable in situ bulk water samplers. The purpose of the study was to determine what factors control the distribution of suspended sediment in the breaker zone. The final conclusion inferred from accumulated data is that sediment transport is highly dependent on breaker type. Net offshore movement and equilibrium profiles can be qualitatively explained on the basis of variations in wave form, beach slope and suspended sediment concentration. Longshore transport rates are dependent not only on wave height, cont.

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20. ABSTRACT CONTINUED

but on breaker type, which can be quantified to reasonable certainty by the simple ratio, d_b/H_b, relative wave height.

d sub b / H sub b

SUSPENDED SEDIMENT

IN BREAKING WAVES

Timothy W. Kana

Technical Report No. 18-CRD

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April 1979

Sponsored by
U.S. Army Research Office
Grants No. DAAG-29-76-G-0111
and No. DAAG-29-79-G-0011

Cover: Sampling suspended sediment in a plunging breaker at Bulls Island, South Carolina.

Bibliographic reference

- Kana, T.W., 1979: Suspended sediment in breaking waves; Tech. Report No. 18-CRD, University of South Carolina, 153 p.

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ABSTRACT

Suspended sediment concentration was measured in 235 breaking waves on undeveloped beaches near Price Inlet, South Carolina, U.S.A., using portable *in situ* bulk water samplers. The purpose of the study was to determine what factors control the distribution of suspended sediment in the breaker zone. As many as 10 instantaneous 2-liter water volumes were obtained in each wave for a total of 1500 samples. Concentrations of suspended sediment were determined at fixed intervals of 10, 30, 60 and 100 cm above the bed for various surf zone positions relative to the breakpoint. The majority of waves sampled during 22 days in June and July, 1977 were relatively long crested, smooth, spilling to plunging in form, with breaker heights ranging from 20 to 150 cm. The beaches sampled are gently sloping (mean beach slope = 0.015), fine-grained (mean grain size = 0.18 mm) and densely compacted with an absence of small scale bed forms.

Suspended sediment in the breaker zone is composed of two fractions; a continuous wash load mode above 60 cm from the bed and an intermittent mode of coarse bed material entrained to lower levels during certain wave conditions. Mean concentration decreases exponentially above the bed to approximately the 60 cm elevation, then maintains a generally constant level up to the water surface. Suspended sediment concentration at the study sites ranged over 3 orders of magnitude up to approximately 10 grams per liter.

The principal factor controlling suspended sediment concentration at a point in the breaker zone is breaker type. Plunging waves typically entrain one order more sediment than spilling breakers. Breaker type for these data can be reasonably quantified as a continuous variable on the basis of relative wave height, d_b/H_b. Plunging waves near Price Inlet occur at $d_b/Hb < 0.89$; whereas spilling waves generally break at $d_b/H_b > 1.10$. Mean concentration increases with decreasing d_b/H_b according to

$$\mathrm{Log}_{10}(SS10) = 17.4 - 1.7\ d_b/H_b,$$

where SS10 is suspended sediment concentration at 10 cm above the bed. This theorized model accounts for almost 60% of the variation in mean concentration by d_b/H_b.

Secondary controlling factors of concentration also include distance relative to the wave breakpoint, beach slope and wave height. Mean suspended sediment in the breaker zone reaches a maximum several meters landward of the breaker line peaking more sharply in plunging than in spilling waves. For the range of slopes in the present study (.004-.040), mean concentration increases according to the model:

$$\mathrm{Log}_{10}(SS10) = .22 + 14.5\ m,$$

where m is dimensionless beach slope.

The relation between wave height and concentration depends on breaker type. There is little or no dependency of concentration on wave height for spilling waves. However, for plunging waves, suspended sediment concentration at a point decreases with increasing wave height.

For the present data collected under moderate swell conditions, suspended sediment concentration is independent of wave period, longshore current velocity, wind velocity and any breaker type parameter involving wave steepness (H_b/L_o).

Although the amount of variation in mean concentration accounted for only ranges up to 65%, these data support the notion that sediment suspension in the surf zone is statistically predictable. The importance of breaker type on concentration suggests that transport of sand in the surf zone is less dependent on wave height and wave steepness than on relative wave height, d_b/H_b.

ACKNOWLEDGEMENTS

Financial support for this study was provided by the U.S. Army Research Office through Grants DAAG-29-76-G-0111 (Miles O. Hayes and Dag Nummedal, principal investigators) and DAAG-29-79-G-0011 (Miles O. Hayes, principal investigator), as well as the Department of Geology, University of South Carolina. My principal advisor, Miles O. Hayes, offered much encouragement during the study and suggested numerous changes to improve the manuscript.

Academic and technical support was additionally provided by several professors, most notably, Dag Nummedal (sediment transport), Robert Ehrlich (geo-statistics), Bjorn Kjerfve (physical oceanography), all from the Department of Geology, and Paul Komar (coastal dynamics - Oregon State University); Benno Brenninkmeyer (suspended sediment - Boston College); and Albert Hine (coastal processes - Institute of Marine Science, UNC). Willing and able field and laboratory support was provided by Dan Domeracki, Walter J. Sexton, Robert Logan, Julie Lumpkin, Denise Domeracki and Sarah Widenhouse. Clerical and editorial support was professionally provided by Pris Ridgell (manuscript), Burk Scheper (photography), Cathi Lee and Nanette Muzzy (drafting).

Finally, I would like to acknowledge with greatest appreciation the help of two research assistants, Dan Domeracki and Helen Mary Johnson. Dan's skills were indispensible during the field experiment, and Helen's efforts were exceptional during preparation of this manuscript.

INTRODUCTION

In June and July, 1977, a study was conducted at two beach sites near Price Inlet, South Carolina to determine the amount of suspended sediment occurring in the breaker zone under moderate swell conditions. The purpose of this experiment was to obtain fundamental information on sand suspension in breaking waves in order to construct a predictive model of sediment concentration. While these data provide the nucleus for a first order model, they represent rather limited conditions with regard to wave type, wave height, beach slope, and sediment grain size and bed compaction.

The principal hypothesis that was tested can be summed up as follows:

> Is the entrainment of sand in breaking waves a random process as variable as the turbulence field in the surf zone -- or is it predictable to some degree on the basis of certain easily measured wave parameters?

To test this, an unique portable water sampling device was designed, and field techniques were developed for obtaining suspended sediment samples directly in breaking waves up to 150 cm high (Figure 1).

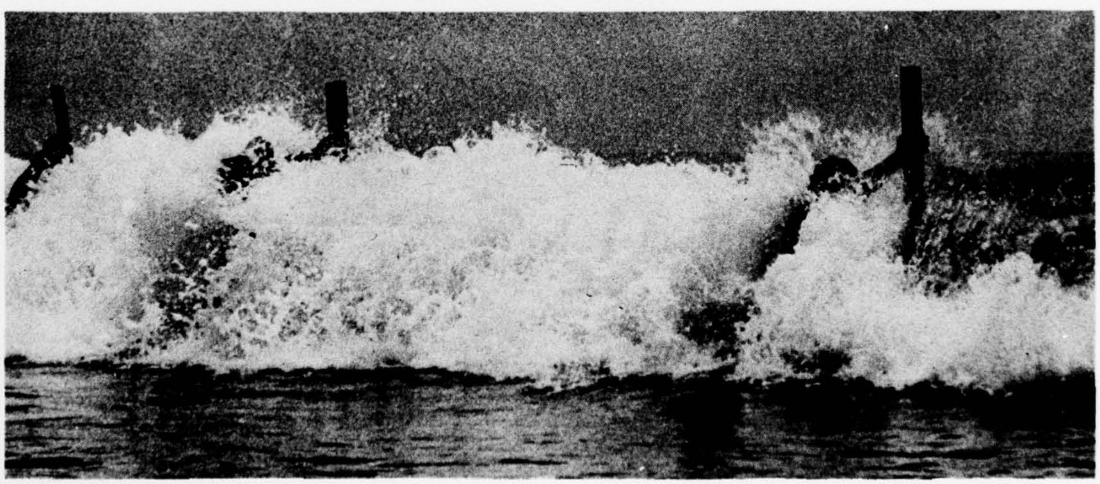


Figure 1. Obtaining samples of suspended sediment in a 110 cm high plunging breaker using portable *in situ* bulk water samplers (see Fig. 4).

The data base for the present experiment includes over 1500 suspended sediment samples collected in 235 individual breakers covering a normal range of swell conditions typical to the South Carolina coast. In addition, numerous wave process and beach profile observations were obtained. Field techniques were basically the same as those applied by Kana (1976a) in an earlier study, but several changes were made to improve control over positioning of the samplers, measurement of wave parameters and photography of the sampling. The experimental design entailed selecting a well defined breaking wave, positioning all suspended sediment samples with respect to the breakpoint and the bed, photographing the wave as it progressed toward shore and measuring the corresponding wave process parameters. The data was evaluated by statistically testing individual and mean values of suspended sediment concentration (dependent variable) against process and location parameters (independent variables).

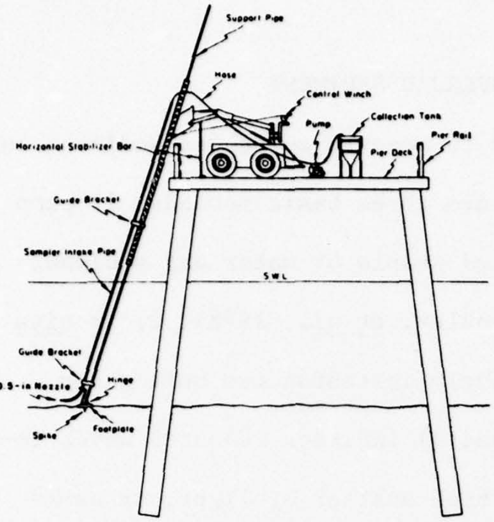
METHODS FOR MEASURING SUSPENDED SEDIMENT

Several techniques have been used to measure suspended sediment concentration in breaking waves. There are three basic methods: 1) pump systems for obtaining a time-integrated sample of water and sediment (Watts, 1953; Fairchild, 1972; and Coakley, et al., 1978); 2) in situ collecting traps for obtaining relatively instantaneous bulk water samples (Kana, 1976b; Inman, 1977); and 3) indirect measures which relate turbidity to light attenuation, back scatter of light, or gamma absorption (Hom-ma, et al., 1965; Hattori, 1969; Horikawa and Watanabe, 1970; Kennedy and Locher, 1972; Basinski and Lewandowski, 1974; and Brenninkmeyer, 1976a). Examples of several systems are shown in Figures 2 and 3. Of the indirect monitors of turbidity, only Brenninkmeyer's has been designed for use in the surf zone. There are certain disadvantages to any of these techniques, most important of which is the influence of the sampling apparatus on the flow field. According to Inman (1977), any device which remains fixed to the bed, or utilizes a supporting structure or pier, is likely to monitor artificially-induced suspensions.

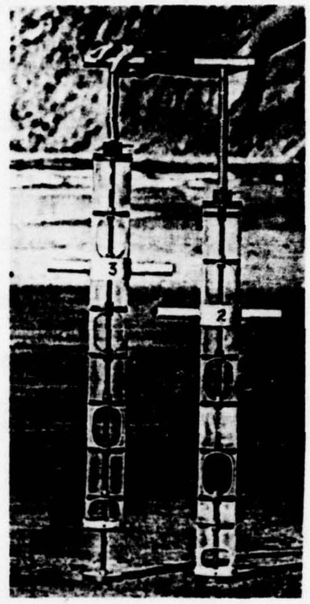
Direct vs. Indirect Measurement

Pump samplers and in situ bulk water samplers have the advantage of providing a direct sample of suspended sediment which can be used for multiple laboratory analyses. However, they only provide a sample for one instant, or a short period, in time, making it difficult to construct a time series of turbidity changes.

The pump samplers used by Watts (1953) and Fairchild (1972) required a pier for support and provided one time-averaged water sample per run. In general, pumping times ranged from 45 seconds to 3

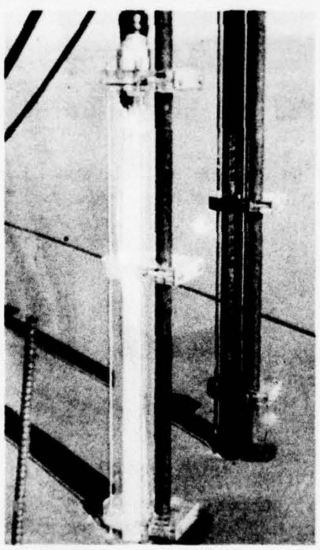


2a. Tractor mounted, pump sampler on a pier (From Fairchild, 1977; Fig. 5).

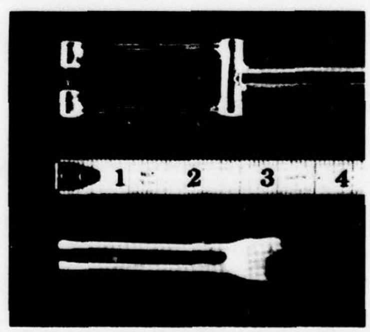


2b. Portable, in situ bulk water sampler which "cores" the water column to provide multiple serial samples (photo courtesy of D.L. Inman, Scripps).

Figure 2. Examples of direct suspended sediment concentration sampling devices used in studies in waves.



3a. Almometer, an array of photoelectric detectors to measure turbidity (From Brenninkmeyer, 1976b; Fig. 1)



3b. The Iowa Sediment Concentration Measuring System (ISCMS). Electro-optical probes used to detect temporal changes in suspended sediment in the laboratory (From Locher, et al., 1977; Fig. 2).

Figure 3. Examples of indirect suspended sediment concentration measuring devices used in studies in waves.

minutes making it possible to measure a mean concentration at a single point. More recently, Coakley, et al., (1978) have reported development of a computerized "robot" sled system for pumping and retaining up to 30 time-integrated samples at pre-programmed positions in the surf zone. These systems have the distinct advantage of remote operation, but do not isolate the effect of a single wave or detect rapid short period bursts of sand from the bed.

Indirect monitors of concentration, such as the almometer (Brenninkmeyer, 1976a), have the advantage of providing detailed time series information on turbidity changes, but most of these devices are difficult to calibrate for field use. They are generally of two types: photoelectric (e.g. Homa-ma, et al., 1965; Brenninkmeyer, 1976a), in which turbidity fluctuations cause voltage changes which are detected by photo cells and related to a calibration curve to determine concentrations; or electro-optical (e.g. Kennedy and Locher, 1972) in which actual particle counts between two closely spaced probes are measured and related to the flow field to determine concentration. Calibration of these devices is done in the lab, but in field use, such external conditions as cloud cover, air entrainment in breaking waves, and the presence of varying amounts of organic matter in the water column, affect turbidity and, therefore, the output of these devices. Also, in some cases, the threshold for detecting sediment bursts from the bed is significantly higher than the typical concentrations found in the surf zone. For example, the concentrations reported by Watts (1953) for a California beach and Kana (1976a) for South Carolina are typically less than 5 grams per liter (g/l), whereas the threshold for detection of suspended sediment by the almometer is calibrated at 5-10 g/l (Brenninkmeyer, 1976a).

Sampling Problems in the Surf Zone

The main considerations for sampling suspensions in the surf zone are considered to be the following:

1) The concentration will depend on a combination of continuous suspension wash load of fine grained particles and an intermittent suspension of coarse bed material. Of these two components, the intermittent suspension is of greater interest and uncertainty.

2) Samples must be collected with respect to elevation above the bed where the intermittent suspension mode originates.

3) Suspended sediment will fluctuate rapidly with the wave period, and bursts of sand from the bed will generally be of short duration.

With these criteria in mind, a portable sampler was designed to collect multiple, relatively instantaneous bulk water samples for determining suspended sediment and isolating the effect of an individual wave on sand entrainment. It was designed to operate simply and at a reasonable cost.

The Simultaneous Water Sampler

The apparatus used in the present study collects several closely spaced simultaneous water samples in a vertical array above the bed (Kana, 1976b). It consists of a 2 meter-long mounting pole, support brackets and several 2-liter cast acrylic bottles closed off by hinged doors (Fig. 4). A spring loaded trigger assembly which holds each bottle door is mounted to the support pole. At the base of the trigger is a footpad which can be pushed up to open the trigger and simultaneously release all bottle doors.

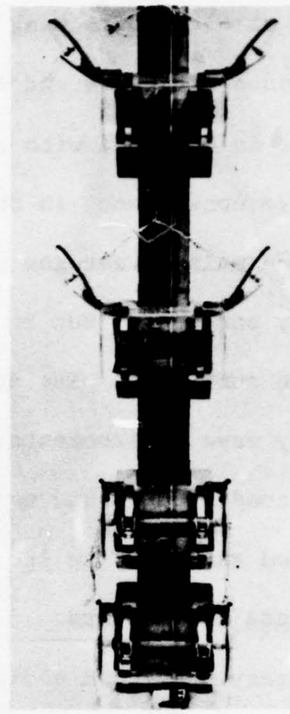


Figure 4. Apparatus used to collect water samples in the surf zone. A 2 m-long pole supporting several 2 liter bottles is emplaced vertically in the surf zone. When thrust into the bed, a footpad moves the rigger assembly up, simultaneously tripping each bottle. Top two bottles are rigged for sampling. Bottom bottles are in the tripped position

To ready the sampler for use, the operator opens the bottle doors and attaches them to a trigger assembly on the mounting pole, similar to rigging a Van Dorn-type water sampler. Then as the bottles are held open, the device is carried into the surf zone and positioned vertically above the bed until the sampling instant. At the desired sampling time, the apparatus is thrust into the bed, forcing the trigger open and allowing the bottles to shut simultaneously, trapping each sample.

The device has a relatively fast response time of less than one-half second, remaining off the bed until the sampling instant. Tests have shown that the collecting bottles are drawn shut before sediment thrown up by the apparatus reaches each sampling position. The typical array of samples collected in this study were centered at 10, 30, 60 and 100 cm above the bed. Because of the relatively broad, stubby shape of each collecting bottle, the lowermost sample obtains sediment suspended between 4 and 16 cm above the bottom. Positioning of each sample is constant with respect to the bed, making it possible to achieve consistency in the results.

The main advantages of this device are its portability, efficiency and cost. But it has the disadvantage of requiring an operator in the surf zone. The sampler is obviously inappropriate for high energy wave environments; however, it has been used for almost all wave conditions found on the South Carolina coast. Wave heights sampled ranged up to 160 cm, including waves generated during a moderate local storm.

Every suspended sediment sampler or meter used, to date, has its limitations. According to Inman (1977), the best way of overcoming present sampling problems is to deploy turbidity meters in combination with portable _in situ_ bulk samplers activated by swimmers. This would provide a physical sample to check the calibration of the meters. The task of coordinating the two measurement techniques, however, is formidable and requires more control and expense than is presently warranted. Our understanding of the causes of suspended sediment variation is limited and would be best served by additional detailed field studies at sites differing in wave climate and beach morphology from West Coast or East Coast beaches. Direct samples of suspended sediment are needed to insure reliability of the data and allow quantification of the effect of wave processes on concentration. The techniques applied in this experiment offer a less than ideal, but efficient and inexpensive way of study suspended sediment in moderate wave conditions.

PREVIOUS RESULTS

It is generally recognized from laboratory studies, that in oscillatory flow, suspended sediment concentration decreases exponentially above the bed (Hattori, 1971; Kennedy and Locher, 1972; and MacDonald, 1977). Field measurements in the surf zone by Kana (1976a) and Inman (1977) (Figs. 5 and 6) tend to confirm this relation. A relatively constant suspension wash load of fine-grained particles exists throughout the water column in the nearshore. However, in the breaker and swash zones, intermittent suspensions of relatively coarse bed material are thrown up by waves to cause the observed vertical distribution of concentration. The frequency and magnitude of these intermittent suspensions are of primary interest because of their importance in the transport of sand on beaches. In general, the timing of bursts of sediment from the bed corresponds to the time of wave breaking, with some delay as the particles lag behind the water motion (Hattori, 1969; Brenninkmeyer, 1976b).

Laboratory and Theoretical Studies

Most of our knowledge of the mechanics of sediment suspension under oscillatory flow and breaking waves is semi-quantitative, based on laboratory experiments performed under controlled conditions. Significant research has been conducted at the University of Iowa, Institute of Hydraulic Research (e.g. Kennedy and Locher, 1972; Locher _et al._, 1976; and Nakato, _et al._, 1977), University of California, Berkeley, Hydraulic Engineering Laboratory (e.g. Das, 1971 and MacDonald, 1977) and the University of Tokyo, Department of Civil Engineering (e.g. Hom-ma, _et al._, 1965; Hattori, 1969; and Horikawa and Watanabe, 1970). For the most part, these experiments deal with sediment suspension under non-breaking progressive or standing waves.

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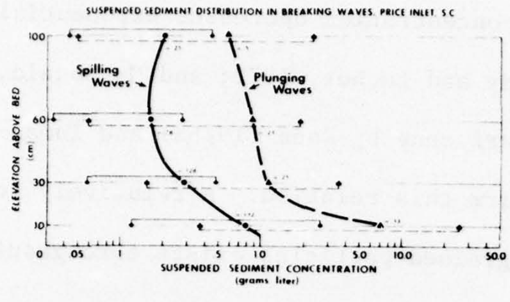


Figure 5. Mean concentration by elevation above bed for approx. 450 suspended sediment samples obtained using the in situ bulk water sampler in Fig. 4 (From Kana, 1976a).

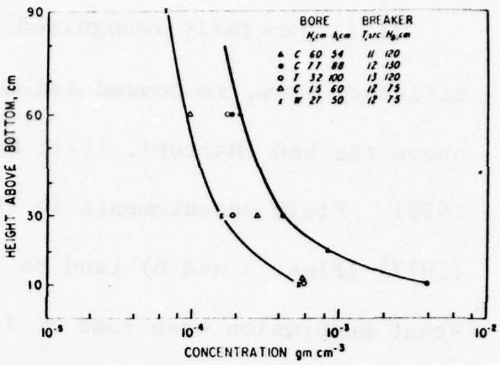


Figure 6. Distribution of suspended sediment at 10, 60 and 90 cm above the bed measured using the in situ bulk water sampler shown in Fig. 13c (From Inman, 1977).

The results from the Iowa group are illustrative of some of the problems involved in measuring sediment suspensions in oscillatory flow. Using small electro-optical probes for measuring turbidity, hot-wire anemometers for obtaining current velocity profiles and a computer data control system for signal averaging to obtain mean, periodic and random concentration and velocity components, Nakato, et al., (1977) were able to identify the suspended sediment distribution over rippled beds under non-breaking waves. They found that suspensions were proportionately higher over the crest of ripples than over the troughs. They also reported that a signal averaged concentration at any position near the bed has four prominent peaks during the wave cycle, originating from the movement past a fixed point of sediment held in suspension by the eddy produced in the lee of each ripple during each half cycle of wave motion. Yet, despite the sophistication of their experiments, they admit to having difficulty in determining the reference concentration needed by engineers to formulate predictive models of sediment transport.

MacDonald (1977), using an oscillating flume, was the most recent investigator to find that mean sediment concentration decreases exponentially above the bed, more or less in agreement with Hattori (1971). Unfortunately, there has been no emphasis on laboratory studies of sediment entrainment in breaking waves.

Perhaps the most helpful laboratory experiment for the present study is one by Miller (1976), in which air entrainment, not suspended sediment concentration, was measured in breaking and non-breaking oscillatory waves. Miller (1976) photographed various types of breaking waves in the wave tank in order to contour the distribution of air bubble concentration. An example of his results is shown in Figure 7. Note that plunging waves, which tend to break more violently, entrain air all the way to the bed; whereas spilling waves break gradually, confining the air entrainment to the surface. This indicates that the turbulence field is significantly different between these two basic wave types, and, by inference, their capacity to entrain sediment from the bed should differ markedly. In agreement with the above, Führböter (1970) also concluded that plunging breakers dissipate their energy over a narrower portion of the surf zone than spilling breakers, as indicated by the distribution of air bubbles.

The laboratory studies mentioned above bring up some important points with respect to the design of the present study. First, it is likely that an exponential decay of concentration above the bottom will occur in breakers, making it imperative that positioning relative to the bed is consistent from one sample to another. A change

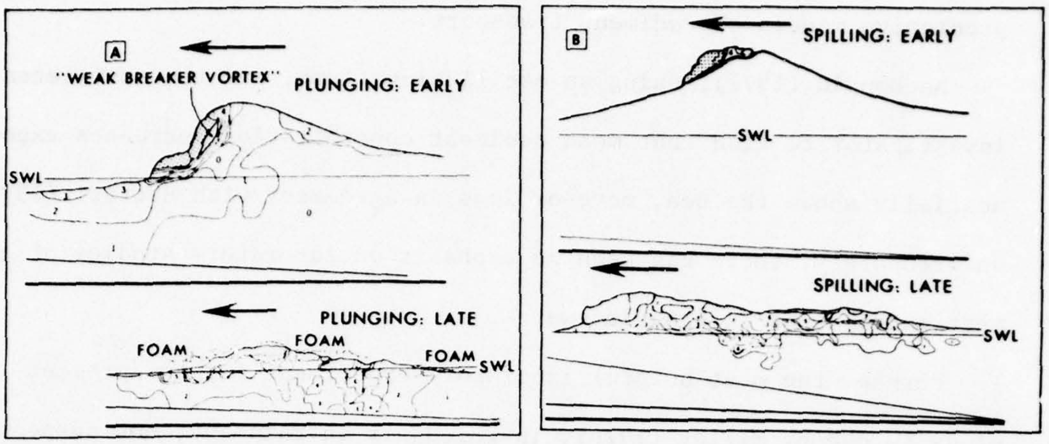


Figure 7. Cross-sectional contour diagrams of bubble concentration in plunging (A) and spilling (B) breakers. Numbers represent percentage estimate of the number of 1 mm scale units containing one or more bubbles (on a scale of 1 to 10). A 5 means 50% of the scale units contain bubbles, a 10 represents 100% bubble concentration. Note that bubbles penetrate to the bed in plunging waves, but remain close to the surface in spillers. This suggests more turbulence reaches the bed in plunging waves, contributing to the observed higher concentrations of suspended sediment for this breaker type (Miller, 1976).

in elevation of a few centimeters may cause a significant change in the concentration. Secondly, the amount of sediment entrained will depend on the turbulence field. This will be affected not only by the total wave energy available, but by the type of breaker. Finally, if the suspensions in the field are periodic, sampling consistency with respect to passage of the wave will be required.

Field Measurements

Very few workers have directly measured suspended sediment concentration in the surf zone. Watts (1953) and Fairchild (1972, 1977) used pump samplers from ocean piers; while, more recently, Coakley et al. (1978) used a bottom sled with preprogrammed submersible pump and collecting system. Each of these techniques provides time-averaged water samples from which sediment is extracted to determine the mean concentration of suspended sediment during the sampling interval. Watts and Fairchild generally collected a 40 gallon sample by pumping for approximately 3 minutes; whereas Coakley's apparatus pumps 2 liter samples in approximately 45 seconds.

Of these studies, the most detailed results are reported in Fairchild (1977), in an updated version of an earlier paper (Fairchild, 1972). Working from ocean piers at Ventnor, New Jersey and Nags Head, North Carolina, he collected over 700 time-averaged water samples in 1964 and 1965 seaward and landward of the breaker zone, using the tractor mounted pump sampler shown in Figure 3. Fairchild, sampling in waves from 40 to 120 cm high, obtained concentration values ranging over 3 orders of magnitude to a maximum of 4.0 parts per thousand. The sampler intake was vaired between 8 cm and 75 cm above the bed.

Despite a great amount of scatter in the data (Fig. 8), Fairchild isolated several trends, including:

1. Suspended sediment increases slightly with breaker height;

2. Concentration decreases away from the breakpoint in both the seaward and landward direction;

3. Concentration decreases with elevation above the bed; and

4. Suspended sediment is more variable in low waves than high.

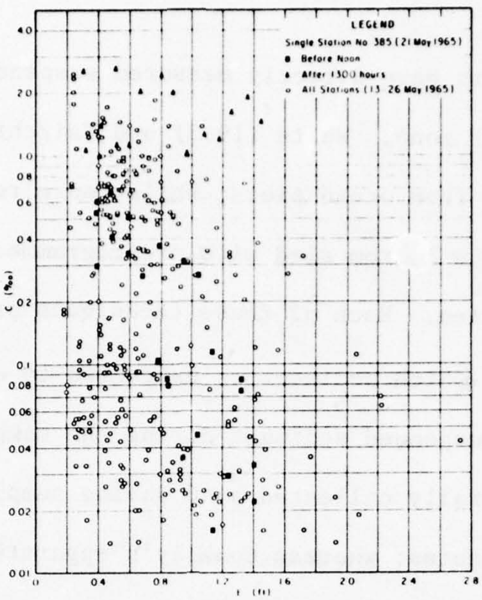


Figure 8a. Scatter plot of suspended sediment concentration (C ^{o}/oo) vs. elevation above the bed (E - ft) for pump samples collected from an ocean pier at Ventnor, N.J. on 21 May 1965 (From Fairchild, 1977; Fig. 18).

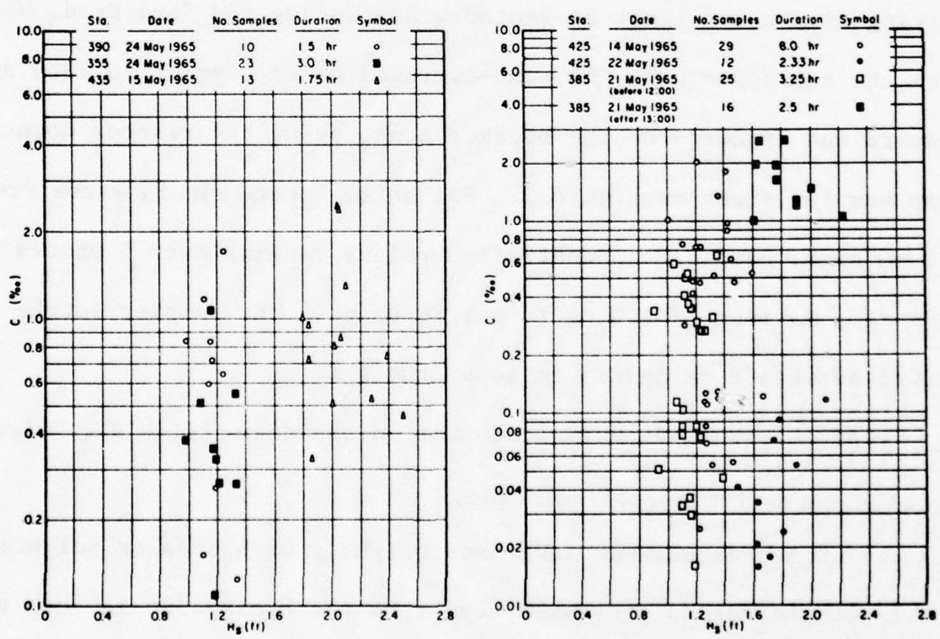


Figure 8b. General lack of relation between suspended sediment (C ^{o}/oo) and significant wave height (H_s) for samples collected at Ventnor, N.J. (From Fairchild, 1977; Fig. 23).

Brenninkmeyer (1973) developed the almometer at the University of Southern California and has used it at Pt. Mugu, California and the Massachusetts and Georgia coasts to obtain detailed time series of turbidity fluctuations in the surf zone. The principle conclusions of his studies indicate that:

1) The zone of maximum suspension occurs near the still water level (the elevation the sea would maintain in the absence of wave action);

2) Suspensions of sand more than 15 cm above the bed are rare in the outer surf zone and appear to be influenced by the stage of the tide and the elevation of the ground water table;

3) Bursts of sediment from the bed or "sand fountains" are infrequent and have durations of the order 2 to 10 seconds, apparently as a function of the phase of incident waves; and

4) The elevation of the bed may change by up to 6 cm during the passage of a single breaker (Brenninkmeyer, 1974, 1976b).

Figure 9 shows a characteristic time series of concentration levels versus elevation above the bed from Brenninkmeyer's (1976b) study. At Point Mugu, California, Brenninkmeyer observed two principal frequencies of occurrence of sand bursts on the upper beach face. As shown in Figure 10, one is at 15 s apparently corresponding to the incident wave period, and another is at 21 s, possibly occurring due to constructive interference of shorter period wave trains.

Loenard and Brenninkmeyer (1978) have used the almometer during storm conditions at Nauset Beach, Massachusetts and, not unexpectedly, concluded that: 1) during storms, sediment suspensions are more prevalent; and 2) the frequency of movement decreases with elevation above the bed and in a seaward direction from the beach. They also

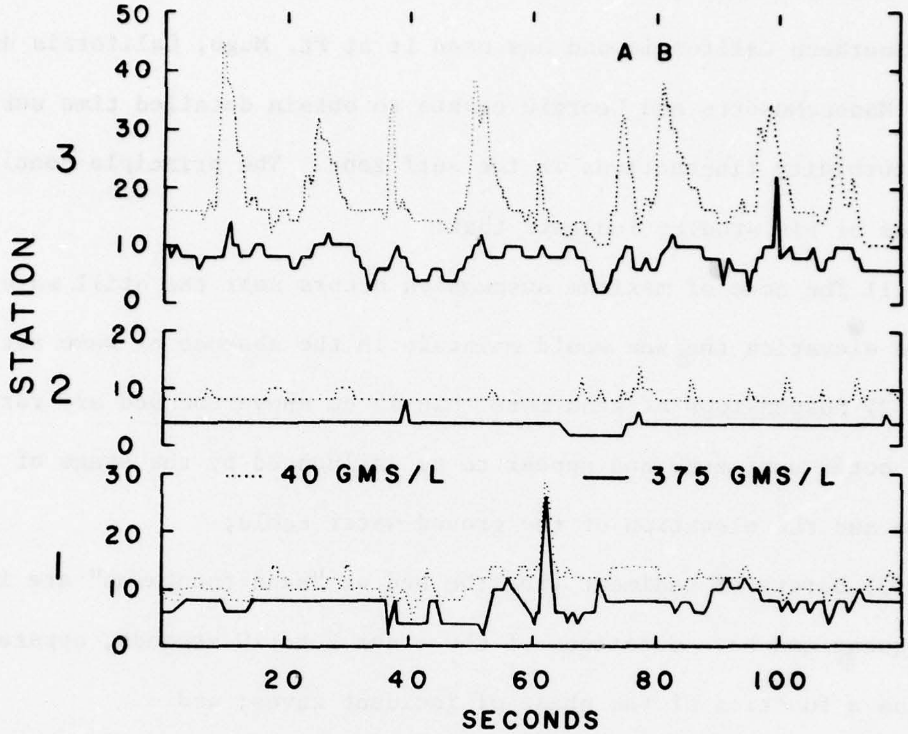


Figure 9. Example two minute record of turbidity fluctuations by elevation obtained from the almometer shown in Figure 3b. The solid line represents a constant value of 375 gm/l, and the dotted line is 40 gm/l. Record #1 (lower) is in the breaker zone; #2 is in the mid-surf zone; and #3 is in the swash zone near the still water level. Note: 1) Suspended sediment concentrations are highest in the swash zone; 2) bursts of high concentration are less frequent in the breaker zone; and 3) the gradient in concentration is generally steepest in the breaker zone (From Brenninkmeyer, 1976b; Fig. 14).

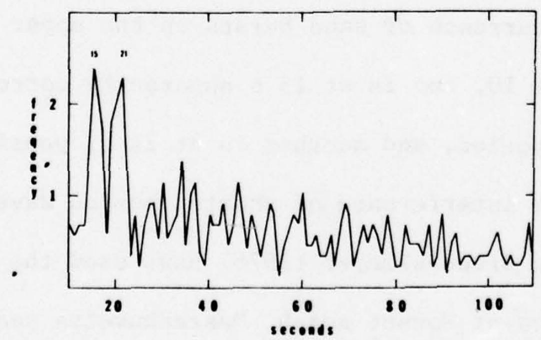


Figure 10. Frequency of occurrence spectrum of sand bursts on the upper beachface at Pt. Mugu, Calif., using the almometer. Dominant frequency of 15 s corresponds approximately to the incident wave period. The second mode may be due to constructive interference of shorter period waves (From Brenninkmeyer, 1976b; Fig. 7).

observed concentration inversions, which occur due to the shearing of tabular clouds of sediment moving in the upper layers. This produces a reverse gradient of higher concentration overlying a zone of lower concentration.

The almometer provides the best information to date on the time series of suspended sediment under field conditions. It suffers from imprecision of calibration and a high threshold of detection, but is an excellent device for obtaining remote information on the semi-quantitative aspects of sediment suspension.

The field measurements of Kana (1976a; 1977) and Inman (1977) were obtained from *in situ* bulk water samplers (Figs. 5 and 6). Kana's data includes approximately 700 concentration determinations obtained from serial arrays of water samples. The means plotted in Figure 5 represent the portion of data collected between 1 and 3 m landward of the breaker line (449 samples) and are divided according to breaker type (based on a visual wave classification). Kana's (1976a) data indicate that plunging waves entrain almost one order more sediment than spilling breakers. Although the data reported by Inman (1977) are minimal being based on relatively few samples, they appear to verify the exponential decay in concentration above the bed.

Despite limitations in all the studies mentioned, these previous experiments provide a starting base for the present study.

STUDY AREA

The field measurements for the present study were obtained at two beach stations (BU2 and CA1), each approximately 2 km from Price Inlet, on Bulls Island and Capers Island, South Carolina (Figs. 11-14). This portion of the South Carolina coast is under the influence of dominant waves from the northeast, causing net longshore transport to the south (estimated rate is $1.2 - 1.5 \times 10^5$ m^3/yr; Kana, 1977). Wave energy is moderate with breaker heights ranging from 20 to 160 cm under non-storm conditions, with a mean of 60 cm.

The beaches at these two sites are composed of well-sorted, fine sand (mean diameter = 0.22 mm) and are gently sloping and relatively featureless (mean beach face slope = 0.018). During average swell conditions, the surf zone is approximately 50 meters wide, but due to the mean tide range of 1.5 meters, a much wider portion of the beach face is periodically exposed to the impact of breaking waves. The bed in the active surf zone is tightly compacted and rarely exhibits small scale bedforms. Slope changes along the beach face are minor and generally controlled by the formation of low amplitude ridges or bars parallel to shore. Figures 15 and 16 show representative beach profiles for each station measured by the Emery (1961) technique.

Sediment grain size along the profile can change significantly due to the presence of varying amounts of shell debris. For example, a series of size frequency curves for bottom sediments along profile BU2 (Fig. 17) show variations in sorting and mean grain sizes. Finest, best-sorted sediments are located at the middle of the berm (17a) and outer ridge (17f); coarser, more variable sediments containing shells are found at the step (17c) and along the runnel (17e).

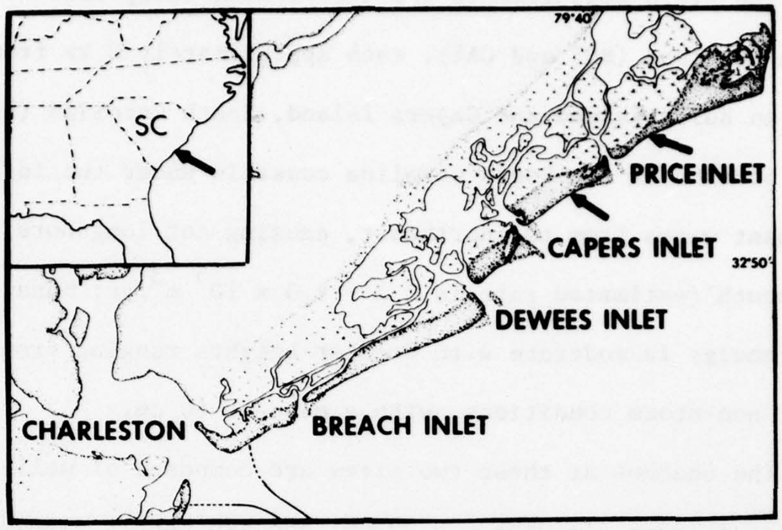


Figure 11. The study area located northeast of Charleston, South Carolina, U.S.A. Suspended sediment samples were collected at stations located along two undeveloped beaches near Price Inlet (arrows).

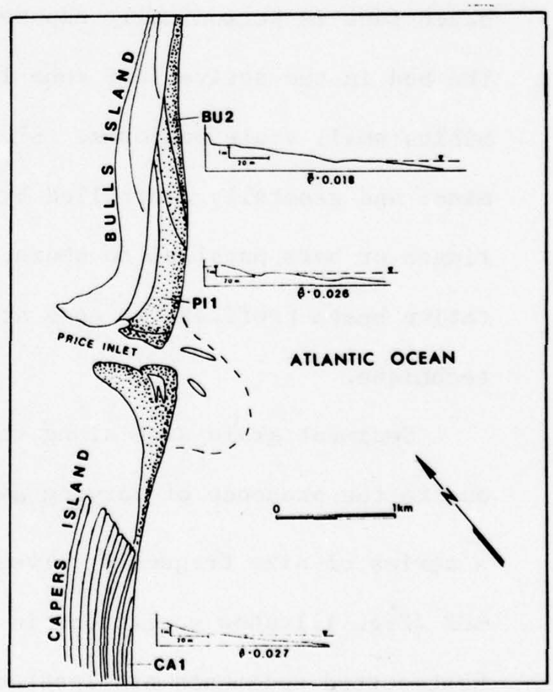
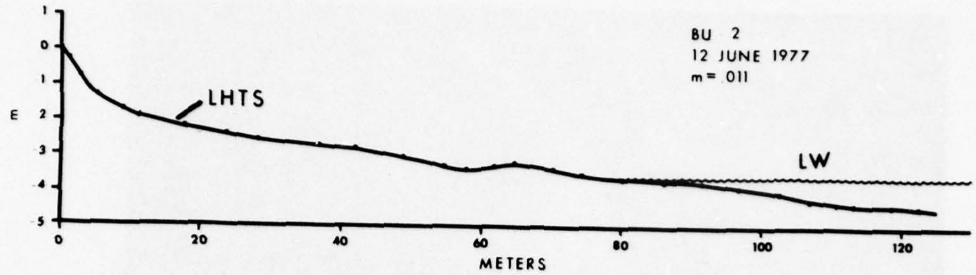


Figure 12. Detailed location map of primary sampling stations, BU2 on Bulls Island and CA1 on Capers Island. A secondary station, PI1, was used to collect some of the samples for size analysis. In general, BU2 has been stable and CA1 erosional over the past 4 yrs.

Figure 13. Oblique IR aerial photo of Bulls Island, looking northeast. Net sediment transport is southeast at 1.3 x 10^5 m^3/yr. (Kana, 1977).

Figure 14. Oblique IR aerial photo of Capers Island looking southeast. Note erosion of antecedent beach ridges which has left a forest of driftwood along portions of the beach.



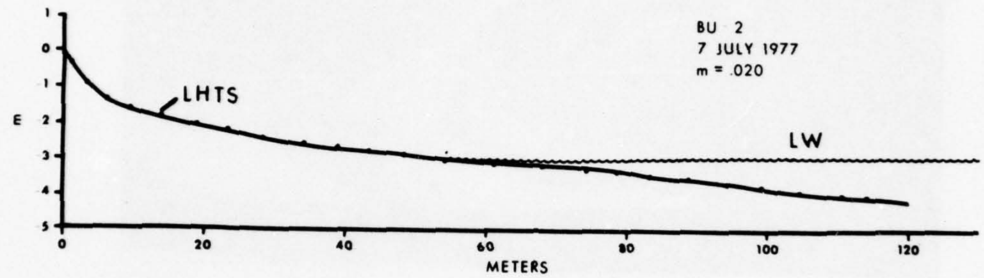
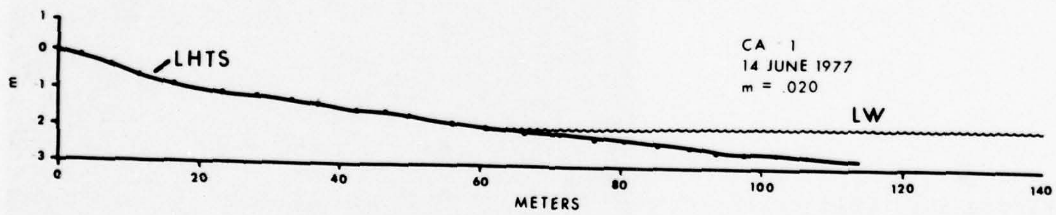


Figure 15. Beach profiles at station BU2 on 12 June (upper) and 7 July 1977 (lower) during the 1 month field experiment. The small amplitude ridge shown on the top profile was gone by 7 July.



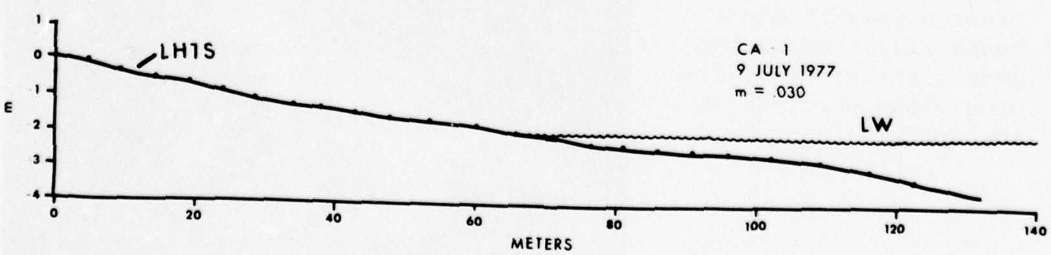


Figure 16. Profiles at station CA1 on 14 June and 9 July 1977, showing a generally featureless profile. Small amplitude ripples or bed forms are essentially absent at both stations.

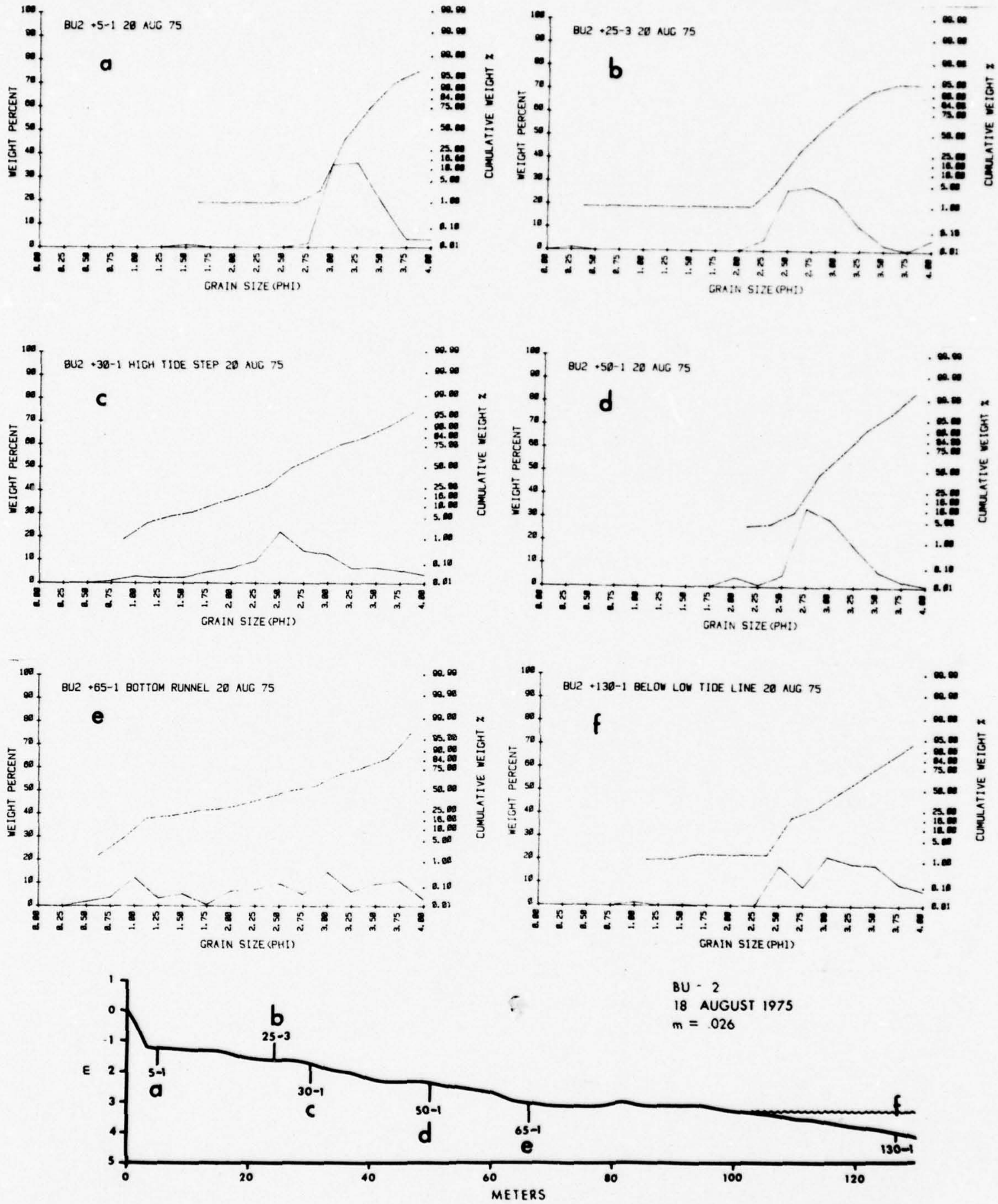


Figure 17a-g. Size frequency curves for bottom sediments along profile BU2 calculated from settling velocities. Sample locations are given in Fig. 17g in terms of a reference distance (e.g. 30-1 which corresponds to grain size distribution in Fig. 17c, labeled "BU2 +30-1 High Tide Step") where the distance is measured in meters from a benchmark on land. Note, finest, best-sorted sediments are located at the middle of the berm (17a) and outer ridge (17f); whereas coarser, more variable sediments containing shells are found at the step (17c) and along the runnel (17e).

EXPERIMENTAL DESIGN

Introduction

Most of the field data reported herein were collected during 22 sampling days in June and July 1977. Additional data collected in 1975 were used to expand the section on size analysis. Since the intent of the experiment was to isolate the effect of individual waves on sediment entrainment, an attempt was made to conduct the sampling under "ideal" swell conditions to facilitate identification and typing of the waves and reduce the variability due to external parameters such as local wind stress. Generally, at these beach sites, waves are more "classically" formed and long crested in the morning before the diurnal seabreeze is established. As onshore wind velocity increases, wave crests become shorter and more irregular, making it difficult to distinguish the breakpoint.

The beaches at these two sites were chosen for the experiment because their profiles are generally featureless, small scale bedforms are essentially nonexistent, and they are away from any artificial structures which may influence turbidity.

The field experiment was designed to select particular waves, then simultaneously sample suspended sediment, measure wave process parameters and record sampling positions with respect to the beach profile, and photograph the sampling sequence. A 4 to 6 man field team was required to coordinate all of these functions.

A range was established at each experiment site and periodically surveyed to the low tide breaker line to calculate the beach slope at each sampling point. Fiberglass stakes were set throughout the surf zone as reference points for sampling location and wave position. In addition, they provided convenient ranges to monitor longshore currents at the surface by means of slightly buoyant floats. Each suspended sediment sample was positioned relative to: 1) the bed, by means of the sampling apparatus; 2) a bench mark on land, by means of the reference stakes; 3) the wave breakpoint, by measuring the distance seaward or landward of each array; and 4) the time of passage of each wave sampled. Figure 18 is a sketch of a typical sampling arrangement.

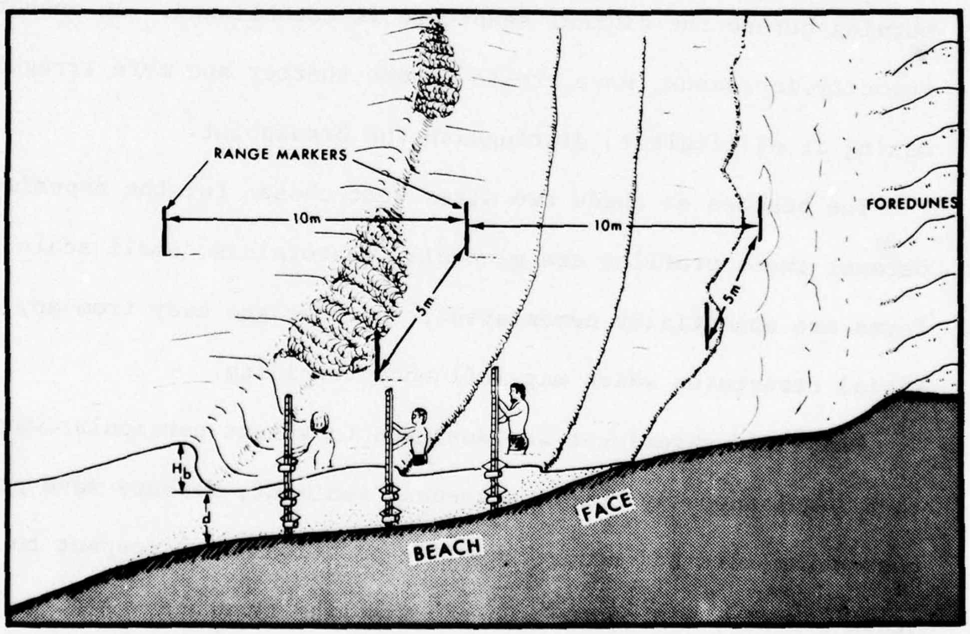


Figure 18. Sketch of the sampling arrangement showing samplers in place. Operators stood downdrift from sample point holding apparatus above bed until sampling instant. Range markers provided reference marks to locate sampling positions, measure longshore current velocity and distances from the breakpoint.

Suspended Sediment Measurements

Suspended sediment samples were collected and recorded by ARRAY. An array consists of all samples trapped simultaneously by one sampling apparatus. In most instances, the number of samples per array was 3, located at 10, 30 and 60 cm above the bed. As many as three arrays, with up to 10 water samples, were collected in each wave to for a SERIES. Thus, cataloguing each sample run, a SERIES designating the wave selected for sampling was recorded. Each SERIES contained from 1 to 3 individual vertical ARRAYS, and each ARRAY contained from 1 to 5 water samples. Samples were classified by their position in the ARRAY. The lowermost sample centered at 10 cm above the bed was designated SS10; the one at 30 cm was SS30, and so on through SS60, and SS100.

The samplers are "rigged" for operation according to the water depths. When small waves are sampled, only the lowermost bottles are mounted to the support pole. Figure 19 shows the bottle doors being cocked for sampling on the beach. Rigged samplers are then carried into the surf by each operator (Fig. 20).

Positioning in the surf is determined with respect to the mean breaker line, using reference stakes as guides. Similar to a surfer positioning himself to ride a wave, each operator positions the sampler at a predetermined distance from the breaker line. In general, the seaward-most operator controls the positioning and spacing between arrays and selects the wave. A fourth person is positioned downdrift and slightly landward of each operator to take a rapid sequence of photographs of the wave sampled. Additional personnel are positioned to measure the breaker height, wave period

Figure 19. Photo of simultaneous water samplers being rigged for operation at station Cal. Collecting bottle doors are held open by the trigger assembly (see also Fig. 4).

Figure 20. Photo of simultaneous water sampler ready for sampling 5 positions above the bed. Total weight with 4 empty bottles is 10.5 kg.

and surface longshore current velocity.

Based on tests conducted during earlier field experiments, it was determined that the most consistent results are obtained when the operator stands downdrift of the sampler, faces alongshore, and holds the apparatus away from his body in a vertical position several centimeters above the bed. At the desired sampling instant, the operator steps forward thrusting the device away from his body and into the bed. As the footpad at the heel of the sampler depresses on striking the bed, each water bottle closes automatically.

For this experiment, each array was collected approximately 2 seconds after passage of the wave bore by the sampler. Results from Kana (1977) and Brenninkmeyer (1976b) indicate that, in general, the maximum concentration at a point occurs after the passage of a wave. Thus, the intent of this procedure was to sample at the probable time of maximum concentration. With three operators, it was possible to follow one wave toward shore and, to some extent, determine the change in concentration across the surf zone.

Approximately 35 waves were sampled with multiple arrays positioned along individual wave crests in order to determine the range of variability of concentration at analogous positions in the breaker. Closest spacing of the samplers was 3 meters.

A typical photographic sequence of the sampling procedure is shown in Figure 21. Appendix A contains a photo atlas of some of the waves sampled categorized by breaker type and height.

After the water samples are trapped in each collecting bottle, the apparatus is carried ashore for transfer of the suspended sediment samples to holding jars. The photo sequence in Figure 22 shows

Figure 21. Four successive photographs of one of the breaking waves sampled at 3 positions inside the surf zone. Arrays of suspended sediment samples taken 3 m, 7 m, and 10 m landward of the breakpoint. Concentrations are listed below.

A. Wave beginning to break 3 m seaward of sampler operator #1. H_b = 90 cm; d = 95 cm; T = 8 s; V = 0 cm/s; m = 0.011; breaker type: spilling; Time = 0 s.

B. Wave fully broken, bore at Operator #1.
Bore height = 70 cm; Depth under bore = 90 cm; Time ~ 1 s.

C. Bore approaching operator #2.
Bore height = 60 cm; Depth = 65 cm; Time ~ 2½ s.
Just before sampling instant array #1 (seawardmost).

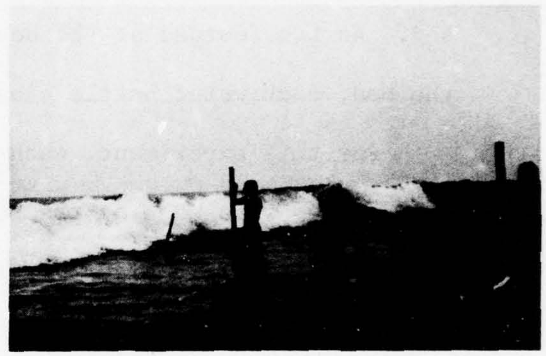
D. Bore at operator #3.
Bore height = 55 cm; Depth = 60 cm; Time ~ 4 s.
Just before sampling instant Array #2.

Results:

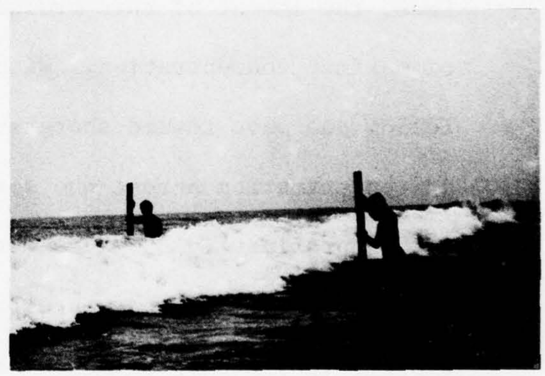
Array #	Elev. above bed (cm)	Conc. (gm/l)
1	60	.135
	30	.256
	10	.329
2	30	.261
	10	.234
3	30	.170
	10	.231

A.

B.



C.



D.

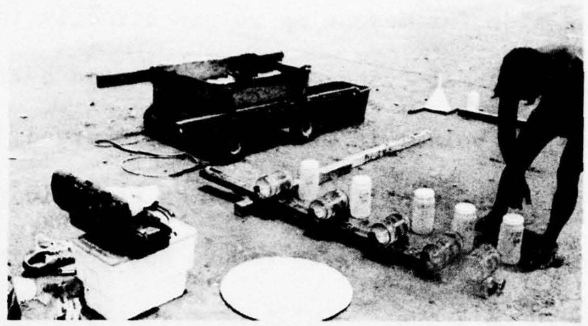


Figure 22a. Array of 5 samples ready for transfer to 2 l. Nalgene holding jars. Sampler bottles are calibrated to measure volume collected.

Figure 22b. Individual samples are opened into a large plastic funnel inserted in a holding jar.

Figure 22c. Sampler bottle is rinsed into the jars with distilled or deionized water to remove any particulates left on the bottle.

the method of transfer. Each collecting bottle has a calibrated scale mounted along the side for measuring volume directly in the field. This eliminates the normal transfer into graduated cylinders before filtering. After the volume is measured and recorded, each sample is emptied through a large funnel into a 2-L Nalgene wide/mouth jar, then rinsed with distilled water to remove any remaining sediment. The jars are stored in a custom built cart then pulled 2 miles along the beach and ferried to a nearby lab for analysis (Fig. 23.).

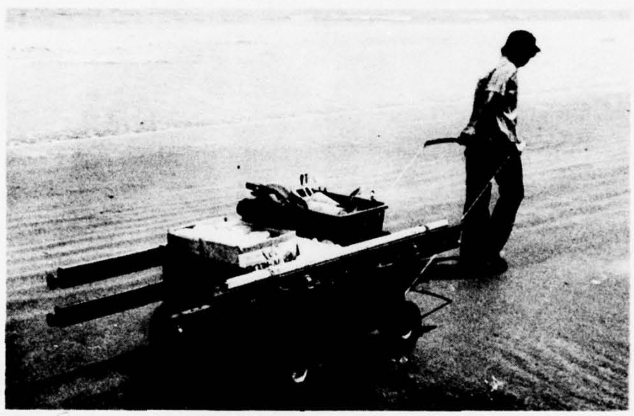


Figure 23. Custom beach cart designed by D. Domeracki used to haul samples and equipment 2 miles down the beach for ferrying to a nearby lab. Brackets at the sides hold sampler poles, profile rods, range markers. Along the open beach, sand is hard-packed, making it relatively easy for 1 person to haul the 200 + kg weight. This is not the case, however, near the inlet where the sand is almost thixatropic.

The number of samples collected each day was restricted by the number of holding jars available and stamina of the operators to pull the load down the beach. Generally, 75 to 100 samples were collected massing up to 250 kg, including samplers and support equipment.

The following surf parameters were measured for each sample array:

1. Breaker height (H_b) and water depth at breaking (d) - visually, by means of a graduate staff held in place at the breakpoint and checked by scaling photographs taken during sampling. Limit of error $\pm$ 10 cm.

2. Bore height and depth under bore at each sample array - by the same method listed above.

3. Breaker type - qualitatively, by visual observations in the field, verified by photos taken while sampling and checked against various breaker-type parameters (e.g. Galvin, 1968; Battjes, 1974).

4. Wave period (T) - by averaging the time of travel between the wave crest prior to, and the crest following, the wave sampled. Limit of error $\pm$ 1 second.

5. Surface longshore current velocity and direction at mid-surf position (V) - by timing the travel of small floats between range markers set 10 m apart in the alongshore direction.

6. Breaker angle (α_b) - visually, by means of a protractor, sighting the acute angle between wave crest and shoreline. Limit of error $\pm$ 2 degrees.

7. Wind velocity and direction - by means of a hand-held anemometer.

Beach Surveying, Sample Positioning and Identification

Beach profiles at each station were measured approximately every 5 days during the experiment to provide information on average beach slope (m) and local slopes (s) at each sample array. Arrays were positioned along the profile with respect to distance seaward of a shore benchmark and distance seaward or landward of the wave breakpoint. Sample time with respect to passage of the bore by each array was estimated to the nearest second.

Other variables recorded included:

1. Station, date and time;
2. Tide from prediction tables;
3. Operator for each array; and
4. Orientation of the series of arrays (either perpendicular or parallel to wave crests).

An example data sheet including reduced concentration data is given in Figure 24.

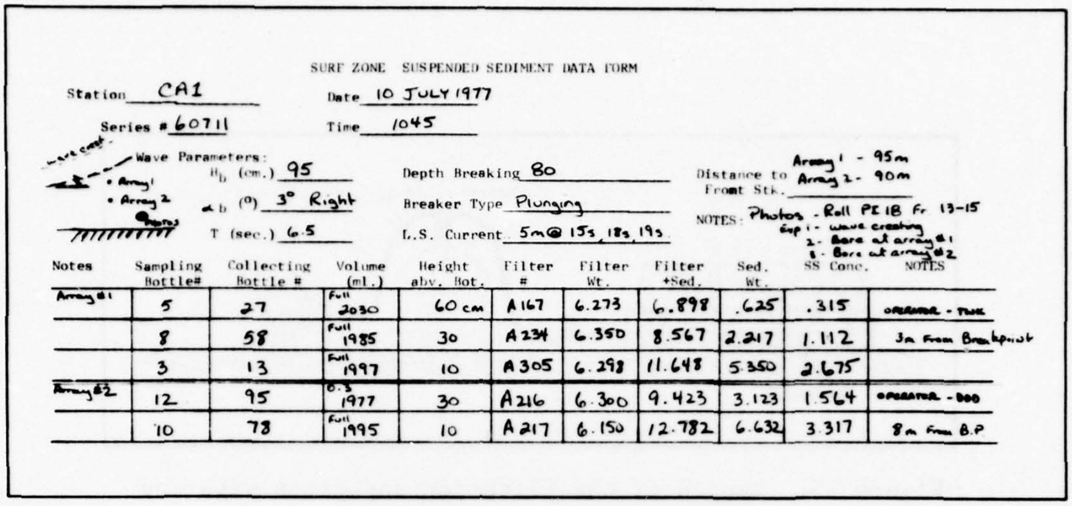
Using up to 3 samplers in each wave, over 230 individual waves were sampled during the experiment, yielding approximately 1500 concentration values. Of these, over 1000 samples were collected at the lowermost positions 10 and 30 cm above the bed.

Table 1 summarizes the range of surf conditions and number of samples collected by wave type and wave height.

Laboratory Procedures

Suspended sediment samples. - In the lab, samples were filtered, using standard filtering apparatus and techniques to retain the suspended sediment. The filtering system used consisted of a Millepore vacuum pump, ballast jug and several manifolds of Millepore filtering flasks (Figures 25 and 26). Up to 20 samples could be filtered at the same time. Millepore 1.2μ, 45 mm diameter cellulose filters were used and stored in locking petri dishes.

Since suspended sediment concentrations can be high in the surf zone, it is necessary to preweigh the filter together with the petri dish to allow for overflow of sediment on the filter. In cases where concentration exceeds 5 g/l, several weighed petri dishes and filters may be required to retain all of the sample. This is easily accom-



SURF ZONE SUSPENDED SEDIMENT DATA FORM

Station CA1 Date 10 JULY 1977

Series # 60711 Time 1045

Wave Parameters:
H_b (cm.) 95
α_b (°) 3° Right
T (sec.) 6.5

• Array 1
• Array 2
Photos

Depth Breaking 80
Breaker Type Plunging
L.S. Current 5m @ 15s, 18s, 19s

Distance to Front Stk. Array 1 - 95m Array 2 - 90m

NOTES: Photos - Roll PE 1B Fr 13-15
Exp 1 - wave cresting
2 - Bore at array #1
3 - Bore at array #2

Notes	Sampling Bottle#	Collecting Bottle #	Volume (ml.)	Height abv. Bot.	Filter #	Filter Wt.	Filter +Sed.	Sed. Wt.	SS Conc.	NOTES
Array #1	5	27	Full 2030	60 cm	A167	6.273	6.898	.625	.315	OPERATOR - TWK
	8	58	Full 1985	30	A234	6.350	8.567	2.217	1.112	3m From Breakpoint
	3	13	Full 1997	10	A305	6.298	11.648	5.350	2.675	
Array #2	12	95	0.3 1977	30	A216	6.300	9.423	3.123	1.564	OPERATOR - DOD
	10	78	Full 1995	10	A217	6.150	12.782	6.632	3.317	8m From B.P

Figure 24. Example field data form.

Table 1. Distribution of samples by wave height and breaker type.

Breaker height Hb (cm)	Breaker Type - # Waves Sampled Spilling	Spill/Plunge	Plunging	#Vertical arrays of* susp. sediment samples
0-35	5	4	2	29
35-45	7	1	3	32
45-55	15	2	5	56
55-65	12	4	1	46
65-75	15	8	10	92
75-85	29	6	7	118
85-95	13	11	18	115
95-105	8	9	5	63
105-115	10	3	2	45
115-125	6	2	1	27
125-160	11	0	0	33
Totals	131	50	54	656

* 3 vertical arrays of 1 to 4 samples each were collected in each wave to yield a total of approximately 1500 concentration values.

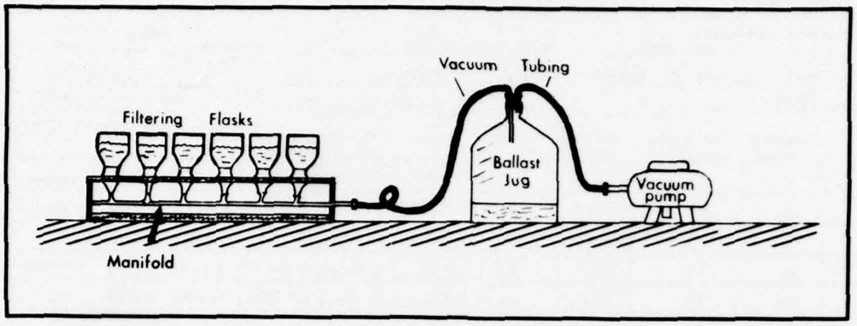


Figure 25. Sketch of the filtering apparatus with the three principal components. Use of several manifolds allowed 20 samples to be processed simultaneously. Filtering times for 2-l. samples ranged from 1 hour to 4 days.

Figure 26. Photo of filtering set up in a temporary field laboratory located at Price Inlet. Rubber "policeman" in Walter J. Sexton's right hand is used to wipe sediment down rim of filtering flasks.

plished by spooning out the excess sediment from the filter flask and transferring it to a second filter. The combined weights of sediment on the two filters are calculated to determine concentration.

Filtered samples were rinsed 3 times with distilled water to remove salt, then stored for shipment to the Department of Geology. The final laboratory analysis entailed drying the filters and sediment at $70^{\circ}C$, then weighing the petri dish, sediment and filter. All concentrations were determined as a weight per unit volume (grams/liter).

Size analysis of suspended sediment. - Approximately 140 samples from the present experiment were analyzed for size distribution using the Hydraulic Equivalent Sediment Analyzer (HESA) developed by Anan (1972) for the Coastal Research Division, Department of Geology. An additional 75 suspended sediment and 45 beach samples collected in a 1975 experiment were analyzed to augment these data. Grain size frequencies were computed and graphed by a Hewlett Packard 9825A minicomputer and 9872A plotter interfaced with the HESA.

Various sample masses were tested to determine the reproduceability of the system. It was found that a 2-3 gram sample was optimal producing almost identical curves for a given sample and means within 2 tenths of a phi unit. Samples of 1 gram varied as much as one-half phi unit. Since most of the suspended sediment samples had relatively low concentrations, only those samples containing at least 1 gram could be sized. Representative frequency plots are given in the section on results.

Computer Coding the Data

The entire data set for this experiment was coded for statistical analysis on the IBM 370/168 computer at the University of South Carolina. The principle data set included all suspended sediment, wave process, location and slope information. A second data set was used for size statistics.

The data were keypunched onto IBM cards, then transferred to internal mass storage on the master disk for more convenient use. Statistical analyses were performed by the preprogrammed Statistical Analysis System (SAS76) and the Statistical Package for the Social Sciences (SPSS). After considerable experimentation, it was found that the SAS76 system was more convenient to use.

Most of the data plots presented in the next chapter were generated by the computer, then redrafted to a more presentable format.

Each sample array is listed as an observation. A typical observation has 32 variables, including sample identifiers, corresponding wave process values, and suspended sediment concentrations at each reference level. Twelve additional variables are computer generated from the field data, including log transformations of concentration and breaker type parameters.

Appendix B contains a listing of computer variable names, a sample SAS76 program, and a data printout for selected observations and variables.

Rejection of Data

A prerequisite to any statistical analysis is the determination of sample distribution. The principle variables were tested for normal distribution by means of normal probability plots. Examples for the independent variables wave height, wave period, ratio d_b/H_b, longshore current velocity, wind velocity, and beach slope are given in Figure 27. Note that each of the data points represents multiple observations. In general, it can be seen that each variable is approximately normally distributed. Beach slope shows, perhaps, the poorest fit. Relatively few outliers (circled on each graph) occur in each sample population.

The dependent variables of suspended sediment concentration (SS10, SS30, SS60 and SS100) were similarly tested, but found to be non-normally distributed. Therefore, various transformations were performed to determine if some function of concentration is normally distributed. A test against the Log_{10} of concentration yielded a reasonable fit to the normal probability plot and, consequently, this transformation was used in the following analyses. Figure 28 gives cummulative frequency curves for SS10 and SS30 plotted on a log scale. A similar relation exists for SS60 and SS100 (not shown). Note concentrations decrease with elevation above the bed and have the widest range of values at the lowermost sample (SS10).

For the present analysis, certain observations were rejected on the basis of the following criteria:

1. Sample array was obtained seaward of the breakpoint or more than 12 m landward of the breakpoint. This was to limit the data to a narrower portion of the surf zone directly influenced by the pri-

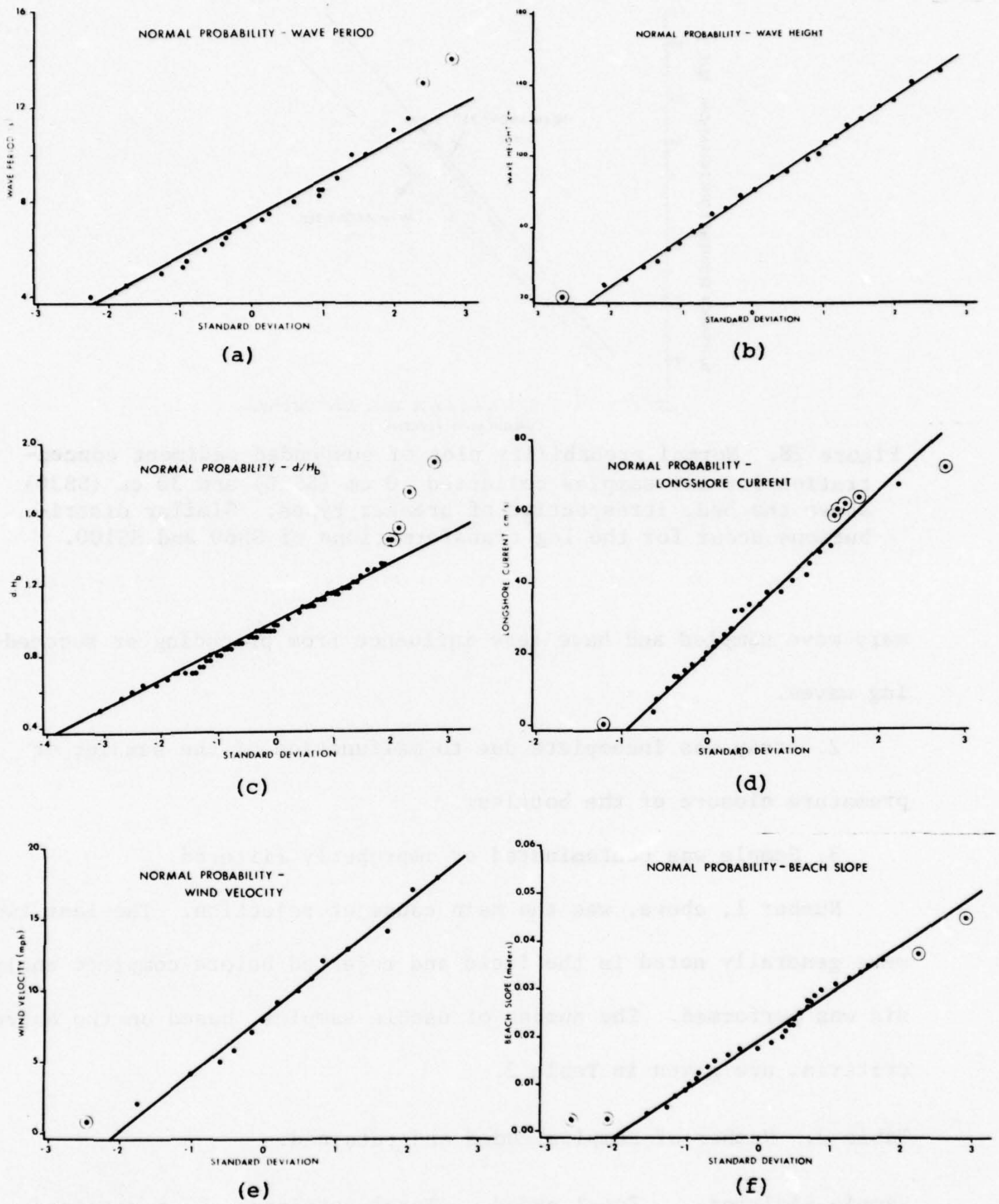


Figure 27. Normal probability distribution for the independent variables wave height (a), wave period (b), ratio db/Hb (C), longshore current velocity (d), wind velocity (e), and beach slope (f). Each data point represents multiple observations.

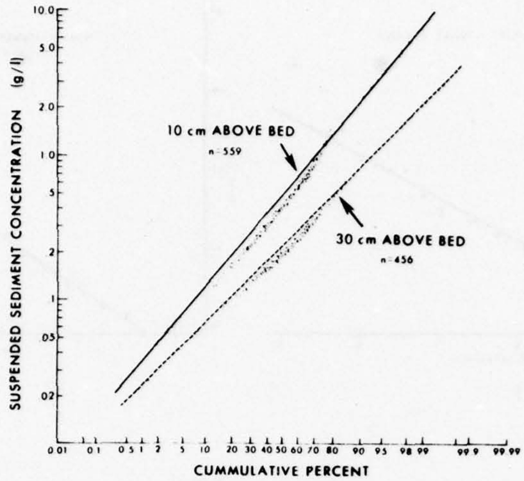


Figure 28. Normal probability plot of suspended sediment concentration for all samples collected 10 cm (SS10) and 30 cm (SS30) above the bed, irrespective of breaker types. Similar distributions occur for the log transformations of SS60 and SS100.

mary wave sampled and have less influence from preceding or succeeding waves.

2. Array was incomplete due to malfunction of the sampler or premature closure of the bottles.

3. Sample was contaminated or improperly filtered.

Number 1, above, was the main cause of rejection. The last two were generally noted in the field and rejected before complete analysis was performed. The number of usable samples, based on the above criteria, are given in Table 2.

Table 2. Number of samples coded and retained.

Sample position	Total coded	Total retained	% retained
SS10	559	405	72.5
SS30	456	343	75.2
SS60	262	175	66.8
SS100	14	11	78.6

RESULTS AND DISCUSSION OF THE DATA

Introduction

This section contains a reasonably detailed description of the data from the present experiment. Since it would be impractical to include scatter diagrams of every independent variable against suspended sediment, an attempt is made to sort the data by the parameters most likely to control concentration. Data sorting was first accomplished by separating samples into the natural categories by elevation above the bed. Next, breaker type parameters were tested against concentration to sort the data into subsets, and finally, the independent variables (wave process and location parameters) were tested against concentration for each subset.

Based on previous results and the inherent variability of surf zone suspensions, the tack employed herein was to sort the data by the independent variables (e.g. wave parameters), determine mean values for the dependent variables (SS10, SS30, etc.), then test the correlation of means against each parameter. By grouping instantaneous suspended sediment samples collected under similar conditions (e.g. with respect to wave height), it is possible to interpret much of the variability observed. Where mean values plotted on the following diagrams represent more than 6 observations, the limits to $\pm$ 1 standard deviation are indicated.

Overall Means

Values of suspended sediment concentration were naturally divided by sample elevation above the bed (SS10, SS30, SS60 and SS100). Similar to an earlier experiment (Kana, 1977), the data were sorted according to breaker type determined visually in the field using Galvin's classification (Fig. 29). Examples of the principle wave types

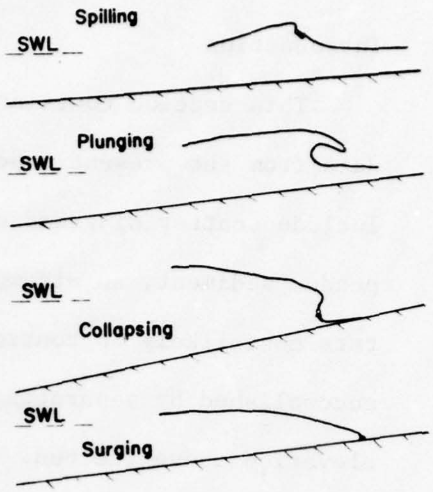


Figure 29. Primary members of the commonly used breaker classification of Galvin (1968). Sketches are typical cross sections at the breakpoint. In general, as beach slope increases, breaker type varies from spilling to surging (From Galvin, 1972).

sampled are given in Figure 30. Galvin's classification actually represents certain members of a continuous spectrum of breaker types. Along South Carolina beaches, spilling and plunging waves are most common, but an intermediate type is often observed which exhibits characteristics of each type. For example, viewing along a breaking wave crest, one often sees portions of a wave spilling early, then a section plunging closer to shore (Fig. 30b). In some cases, the percentage of the wave spilling or plunging can be estimated and coded appropriately (e.g. 50/50 for 50% spilling and 50% plunging). Waves that were not clearly spilling or plunging were designated under the category, <u>TRANSITION</u>. Non-breaking waves were so classified and eliminated from the present analyses. In summary, three categories of waves were used: <u>SPILLING</u>, <u>TRANSITION</u> and <u>PLUNGING</u>.

Figure 31 gives overall mean suspended sediment concentration by elevation above the bed and visually classified breaker type. The breaker type parameters B_b and d/H_b listed on the figure are discussed in the next section. Note that plunging type waves susa

b

c

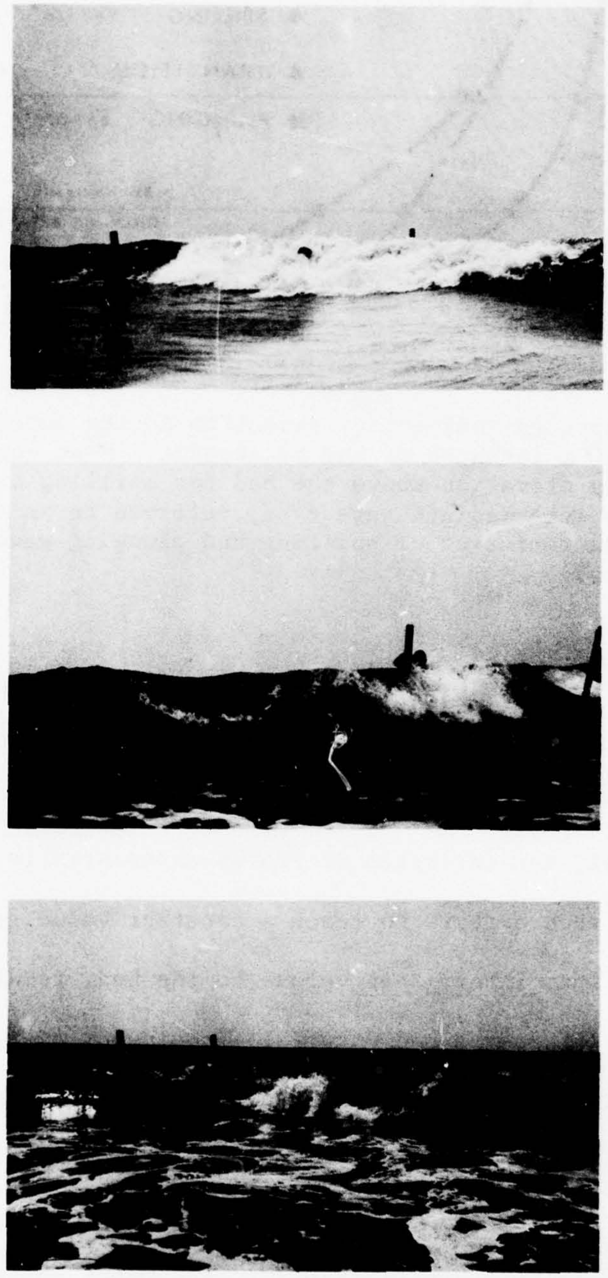


Figure 30. Breaker types most commonly observed near Price Inlet, S.C, including spilling (a), transition (b) and plunging (c). Transition waves exhibit characteristics of both primary wave types. In general, the ratio breaker depth to breaker height, (db/Hb), decreases from spilling to plunging waves with a value of approximately 1.0 in transition waves.

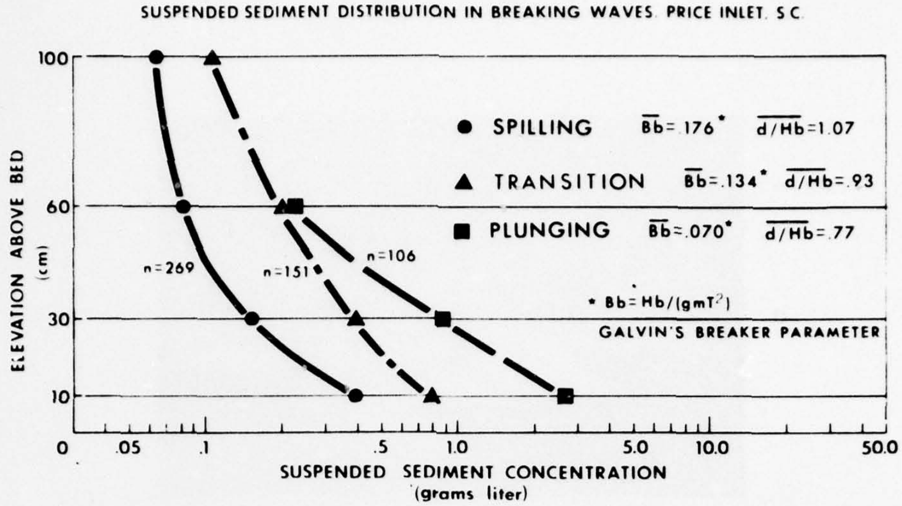


Figure 31. Suspended sediment distribution in the outer surf zone between 1 and 10 m landward of the breakpoint. Mean concentrations are plotted by elevation above the bed for spilling and plunging type breakers. An intermediate wave type, referred to as transition, exhibiting characteristics of spilling and plunging waves is also plotted (triangles).

pend as much as one order more sediment than spilling waves. The curve for transition waves, of course, falls between the two primary wave types.

In general, concentration decreases exponentially up to 60 cm above the bed, then appears to reach a constant value, reflecting the type of suspension: intermittent close to the bed, resulting from periodic bursts of coarse bed material; continuous near the surface, due to the dominance of suspended wash load. Based on separations the sand-silt boundary (sediment diameter = 0.063 mm), the wash load of silt and clay sized sediment averaged less than 0.05 g/l in each sample. Consequently, samples higher in the water column but lower in concentration have the highest percentage of fines. This will be discussed in more detail in the section on size distribution.

Table 3 contains a listing of mean values of selected variables sorted by date. A more complete data listing is given in Appendix B.

Table 3. MEAN VALUES FOR SELECTED SUSPENDED SEDIMENT AND WAVE PROCESS VARIABLES BY DATE.

Date (1977)	SS10 (g/l)	SS30 (g/l)	d_b/H_b	Predominant Breaker Type	Beach Slope	H_b (cm)	d_b (cm)	T (s)	V (cm/s)	α_b (°)	Wind (mph)	# SS Arrays
11 June	.189	.058	1.13	spilling	.018	61	69	7.5	3	0	8.8	39
12 June	1.151	.645	1.08	spilling	.019	67	75	5.4	32	6	10.7	26
13 June	.449	.263	.85	plunging	.016	75	64	6.6	16	5	3.1	36
14 June	.627	.308	1.01	transition	.017	90	90	6.9	34	4	11.9	21
15 June	2.155	1.035	.94	plunging	.011	61	57	8.4	8	4	4.1	37
16 June	.373	.169	1.21	spilling	.012	54	62	7.4	40	9	10.6	20
18 June	.436	.096	1.14	spilling	.019	40	45	8.1	0	0	9.2	34
19 June	.298	.184	1.05	spilling	.022	59	60	4.8	43	9	12.7	21
20 June	.269	.133	1.00	transition	.018	98	98	6.3	34	6	7.0	27
21 June	1.287	.271	.85	plunging	.012	50	45	6.1	12	0	8.9	16
28 June	1.608	.243	.92	plunging	.023	62	58	7.5	5	0	5.3	42
29 June	3.173	.878	.72	plunging	.023	84	60	7.7	39	1	7.5	32
30 June	.912	.506	.87	plunging	.018	81	70	7.4	26	4	7.0	19
1 July	.849	.451	.97	transition	.026	87	84	7.2	44	4	15.1	27
2 July	1.046	.396	.85	plunging	.023	90	77	9.6	14	3	3.3	35
4 July	.456	.207	.98	transition	.019	92	89	8.1	20	3	6.0	33
5 July	.358	.281	.93	plunging	.024	94	88	8.0	0	0	4.0	20
6 July	.301	.182	.97	transition	.018	121	117	4.9	24	3	11.4	29
7 July	1.077	.338	.99	transition	.023	109	108	6.2	34	5	9.0	23
8 July	.587	.330	1.01	transition	.018	105	107	5.2	61	3	13.0	19
9 July	.477	.462	.90	plunging	.029	94	85	6.0	7	2	10.0	5

Tests of Concentration vs. Breaker Type Parameters

Introduction. - Since breaker type may be a very significant factor controlling the magnitude of intermittent suspensions in the surf zone, it is desirable to obtain relations which quantify wave variability. According to laboratory studies by Patrick and Wiegel (1954), and Galvin (1968, 1972), the way a wave breaks at the shore is primarily dependent on the parameters of beach slope (m), wave height (H_b), and wave steepness (H_b/L_o), where m is measured as the tangent of the acute angle between beach face and horizon, H is wave height measured from trough to crest, and L is wave length measured between successive crests, and the subscripts b and o refer to inshore breaking dimensions and offshore deepwater conditions, respectively. From Airy (1845), linear wave theory, L_o is related to wave period (T) by:

$$L_o = \frac{gT^2}{2\pi} , \qquad (1)$$

where g is the acceleration of gravity. Thus, wave steepness is often given in terms of H and T since these parameters are more commonly measured.

The above relationships have allowed Galvin (1968) and Battjes (1974) to present two breaker type parameters based on wave steepness and beach slope. Galvin's dimensionless onshore parameter (B_b), utilizing surf zone wave measurements, is given by:

$$B_b = H_b/\ (gmT^2). \qquad (2)$$

Data obtained on plane concrete laboratory beaches set at various slopes give the following transition values between wave types: 0.068 between spilling and plunging waves; 0.003 between plunging and surging waves.

Battjes (1974) gives a surf similarity parameter (ξ- Greek letter XI) defined by:

$$\xi = m/(H_b/L_o)^{\frac{1}{2}} . \qquad (3)$$

A simple transformation gives this parameter in terms of wave period as:

$$\xi = m/(2\pi H_b/gT^2)^{\frac{1}{2}}. \qquad (4)$$

Battjes' transition values between breaker types are numerically different, but equally comparable with Galvin's. Approximate values listed by Battjes (1974, p. 470) are: $\xi = 0.4$ between spilling and plunging; and $\xi = 2.0$ between plunging and collapsing.

Although B_b and ξ can be readily applied since the dependent variables H_b and T are easy to measure, and they appear to separate major wave types, it is the opinion of the writer that these parameters are not sensitive enough to distinguish among waves of a particular class at one beach. Experience has shown that on a given beach, most waves will fall within a small range of T, H and m values. B_b and ξ will vary only slightly. The main advantage of these parameters is in comparison of waves on different beaches. It is also the opinion of the writer that they lack the fundamental parameter, relative wave height, which should be considered in describing wave breaking.

Breaker types form a continuum ranging from spilling breakers on gentle slopes through plunging and collapsing on steeper slopes, then, finally, surging waves on very steep to vertical slopes (Figures 29 and 30). And as Galvin (1972) shows, for a given beach slope with a variation in wave height alongshore, breaker type changes as follows:

highest waves are generally spilling; higher intermediate waves are plunging; lower intermediate waves will tend to be collapsing, and the lowest waves will be surging. As beach slope and wave energy cause a variation in breaker type, relative wave height also changes.

Relative wave height is generally defined as the ratio H_b/d_b, where d_b is the depth at breaking. Munk (1949) was one of the first to recognize its importance in surf problems and used it as the fundamental parameter in his development of Boussinesq's (1872) solitary theory for the special case of shoaling water waves. Munk argues that wave length, a function of T, has little to do with the shape of waves near the breakpoint since waves in very shallow water commonly have long, flat troughs and steep, sharp crests. Solitary theory differs from linear theory by eliminating the dependence on T or wave steepness.

Another reason for retaining relative wave height is its variability at the breakpoint. Although McCowan (1894) demonstrated theoretically and Munk (1949) empirically that the maximum ratio of H_b/d_b at breaking should be 0.78, measurements by Ippen and Kulin (1955) indicate that breaking occurs over a range of H_b/d_b values greater than 0.78, depending on the slope. On steep slopes, Ippen and Kulin found that H_b/d_b may exceed 2.8. In the field, it's been noted by Galvin (1972) that collapsing waves on steep slopes break against the beach face where d_b is close to zero, and H_b/d_b will approach ∞! Thus, as H_b/d_b at breaking increases, waves will pass through a continuum of breaker types starting with spilling at the lowest relative wave heights, then to plunging and collapsing at intermediate H_b/d_b values, and finally to surging at highest values.

In summary, for purposes of formulating a breaker type parameter, not only H_b, T and m should be considered, but also breaker depth, d_b[1].

Galvin's Parameter (B_b). - The dependent variables SS10, SS30 and SS60 were plotted against Galvin's inshore parameter (B_b), as a first attempt to quantify breaker type. In all cases, the scatter is considerable. A plot of SS10 vs. B_b for samples collected up to 12 m landward of the breakpoint is given in Figure 32. Each data point represents a mean concentration for a particular B_b value. Note that most of the data falls near the spilling-plunging transition value. Although the regression line is significant at the .04 level, it accounts for almost none of the variability in the data (r^2= .03). Furthermore, the relatively flat slope of the regression line suggests that B_b is unsatisfactory as a predictor of concentration by wave type. Figure 33 shows calculated regressions of SS10, SS30 and SS60 on B_b, all of which are inadequate for distinguishing these data. The separation of the lines between SS10 and SS30 is not surprising given the exponential decay of concentration above the bed indicated in Figure 31.

Battjes' Parameter (ξ). - When plotted against mean concentration, Battjes' (1974) surf similarity parameter (ξ) provides similar results as Galvin's B_b. Figure 34 shows the scatter of SS10 values vs. ξ for samples collected within 12 m landward of the breakpoint. Although there is an apparent increase in concentration with increasing ξ, in agreement with the expected trend from spilling to plunging waves, the separation of wave type and concentration is poor. Further-

1 In this discussion, relative wave height is H_b/d_b using the conventions of the theorists. However, for purposes of analysis, the commonly applied engineering inversion of this relation, d_b/H_b, will be used. McCowan's (1894) breaking criteria under this convention then becomes the oft-cited d_b/H_b = 1.28.

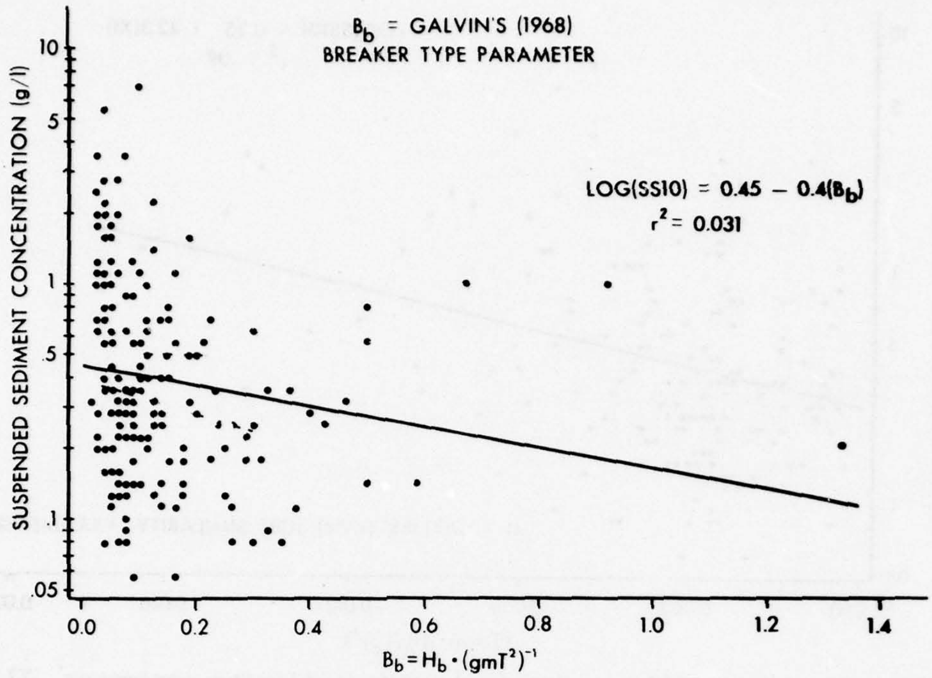


Figure 32. Scatter plot of mean SS10 vs. Galvin's inshore breaker type parameter (B_b). Data is concentrated near spilling/plunging transition value of .068. There is essentially no correlation between Bb and suspended sediment concentration for these data.

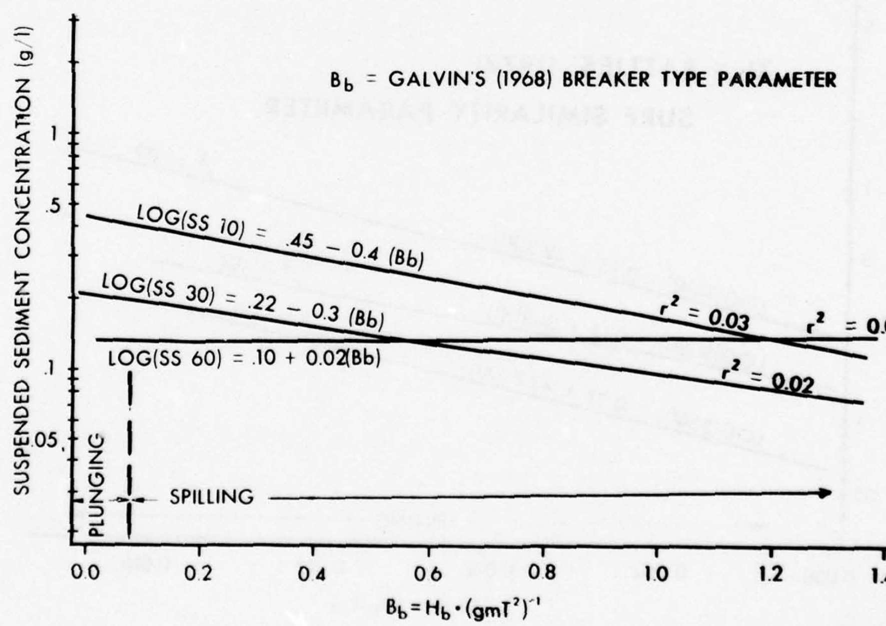


Figure 33. Linear regression models of SS10, SS30 and SS60 vs. B_b for suspended sediment samples within 12 m landward of the breakpoint. Miniscule correlation coefficients and flat slopes of curves indicate these models are inadequate for predicting concentration by this breaker type parameter.

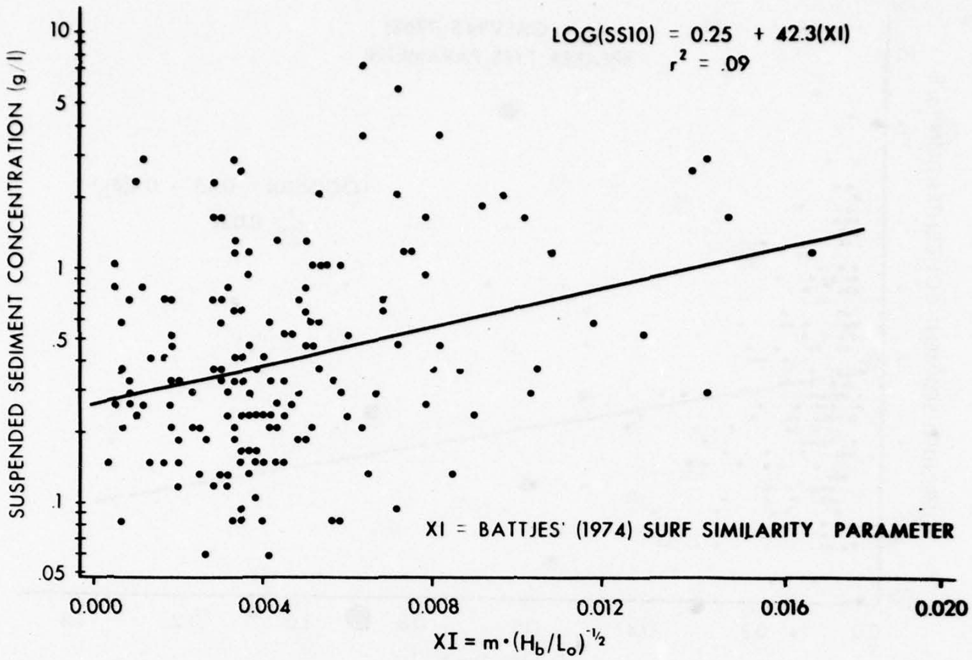


Figure 34. Mean SS10 vs. Battjes' surf similarity parameter, XI. All data fall within the spilling range given by Battjes (plunging waves are off the scale to the right). There is slightly improved correlation over Galvin's B_b; however, less than 10% of the data are accounted for by the indicated regression line.

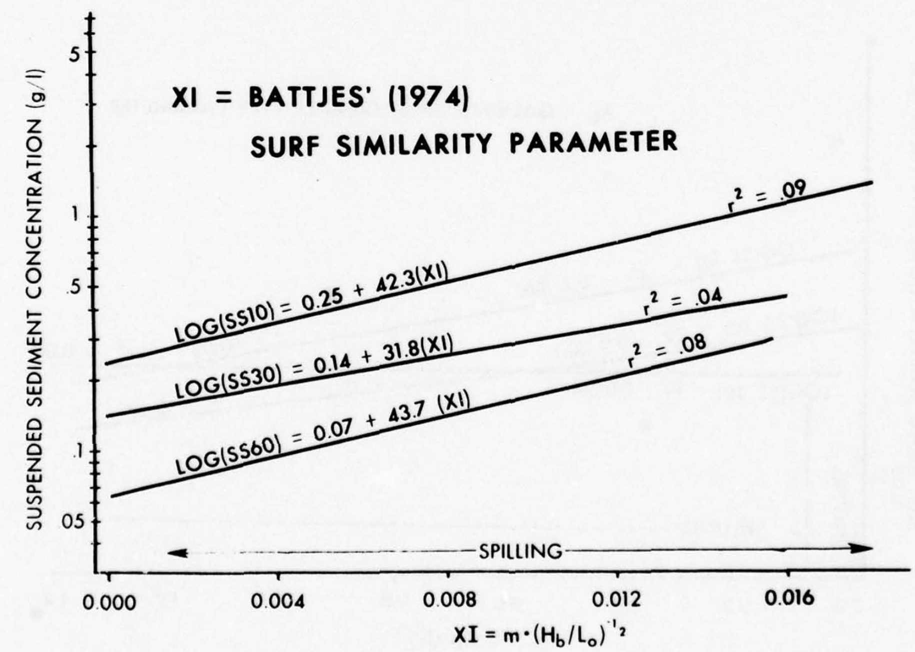


Figure 35. Linear regression models of SS10, SS30 and SS60 vs. XI for suspended sediment samples within 12 m landward of the breakpoint. All lines account for less than 10% of this variability and are unacceptable as a predictor of concentration.

more, all the data plot within the spilling range given by Battjes.

Figure 35 gives the probable regression lines for SS10, SS30 and SS60 against ξ. The separation by sample position is clear, but the regression lines account for less than 10% of the variability in the data.

Parameter BRKER. - Because of the poor fit of the data to published breaker type parameters, several alternative functions were calculated and tested. Although this was a hit or miss proposition in the beginning, since few of the independent variables correlated well with the data, it was apparent during field observations that relative wave height changed significantly from spilling to plunging waves. Therefore, a function was sought which included the ratio of wave height to breaker depth, or, using the engineer's convention, d_b/H_b. Another variable thought to be important is beach slope, m. So, various dimensionless quantities involving d_b/H_b and m were tested against the concentration data.

One such function was designated BRKER, after the computer coding. BRKER is given by:

$$\text{BRKER} = (1-m)^4 \cdot d_b/H_b \tag{5}$$

There were several reasons for retaining the form $(1-m)^4$. First, d_b/H_b ranges from .6 to 1.4 (plunging to spilling), while m ranges from 0.002 to 0.040 for these data. From a practical standpoint, it was preferable to obtain BRKER values of the order 1.0. This was accomplished by using (1-m) instead of m. Furthermore, it was hypothesized that plunging breakers should occur on steeper slopes at lower d_b/H_b values. The function (1-m) multiplied by d_b/H_b theoretically should increase the range of values corresponding to breaker types. As m increases and d_b/H_b decreases in plunging breakers, function BRKER will decrease. In spilling waves with small m and large d_b/H_b, the function stays large. Thus, there should be a better separation between breaker types using this form. The exponent was added simply to increase the range of values of (1-m).

Comparing function BRKER to visual typing of waves indicated the following range of values correspond to each breaker type:

Spilling	-	BRKER > 1.07
Transition	-	0.91 - 1.07
Plunging	-	BRKER < 0.91.

The relation between BRKER and SS10, SS30 and SS60 are given in Figure 36. It is evident that, for these data, this function yields a much better separation of concentration values by wave type than Galvin's or Battjes' parameters. Each data point represents the mean of 2 to 5 samples taken under similar conditions with respect to m and d_b/H_b. In addition, the regression lines yield values of concentration very close to those obtained using a visual wave classification given in Figure 31. For example, for SS10 (Fig. 36a), this function gives mean concentration values for plunging waves in the approximate range 0.4 to 2.0 and spilling from 0.05 to 0.2, the order of magnitude difference previously noted. Based on the relatively high number of mean data points for each sample, the indicated regressions are statistically significant at the .01 level and account for as high as 41% (SS10) of the variability in the data. There is still a lot of variation to account for, but function BRKER appears to separate wave types observed at Price Inlet better than the two published breaker parameters.

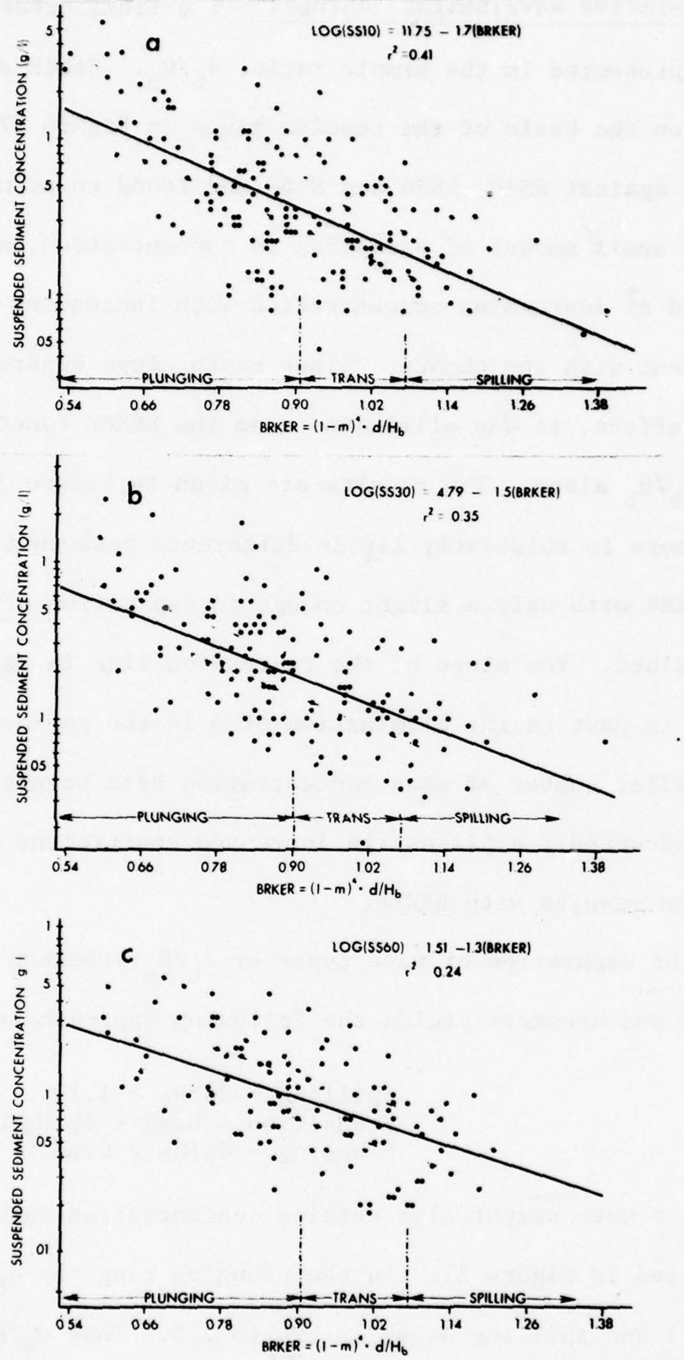


Figure 36. Linear models of SS10 (a) and SS30 (b) and SS60 (c) vs. parameter BRKER, showing much improved correlation. This function yields mean suspended sediment concentrations for SS10 in the range 0.4 to 2.0 for plunging waves and 0.05 to 0.2 for spilling, corresponding to the range of values and order of magnitude difference obtained using a visual breaker classification (Fig. 31).

Relative wave height (d_b/H_b). - The final breaker type parameter to be presented is the simple ratio, d_b/H_b. Beach slope, m, is eliminated on the basis of the results given in Figure 37. Beach slope was tested against SS10, SS30 and SS60 and found to account for a relatively small amount of variation in concentration, although there exists a trend of increasing concentration with increasing beach slope in agreement with the theory. Since beach slope apparently has a rather small effect, it was eliminated from the BRKER function in order to test d_b/H_b alone. The results are given in Figure 38.

There is relatively little difference between the plots of d_b/H_b and BRKER with only a slight change in separation of the concentration values. The slope of the regression line in Figure 38 is steeper due in part to the elimination of m in the parameter, as well as the smaller number of mean concentration data points for d_b/H_b. This undoubtedly explains the increased coefficient of determination over the results with BRKER.

The separation of wave types by d_b/H_b, checked against the visually typed breakers yields the following approximate ranges.

Spilling - $d_b/H_b > 1.10$
Transition - $0.89 < d_b/H_b < 1.10$
Plunging - $d_b/H_b < 0.89$

Relative wave height also retains concentration values in the ranges indicated in Figure 31. In the plunging range by d_b/H_b, SS10 is .5 to 2.0 g/l and spilling waves is .04 to .15. Thus d_b/H_b appears to be a fairly good indicator of breaker types for these data.

Sorting the data by d_b/H_b. - From the previous results, it was deemed possible to classify wave types on the basis of the quantifiable variable, d_b/H_b. Despite a significant amount of data variation

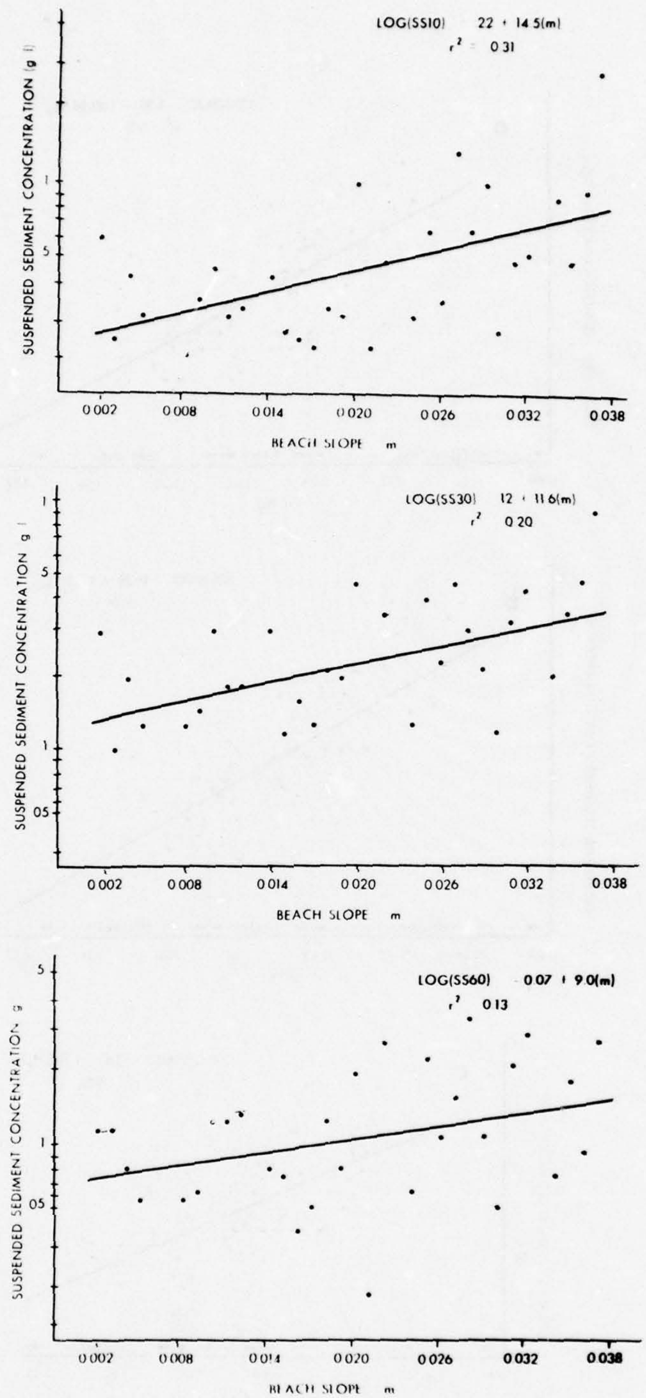


Figure 37. Mean SS10 (a), SS30 (b) and SS60 (c) vs. beach slope (m) showing general increase in concentration with increaing slope. Indicated regression lines account for up to 31% of the variability in mean concentration.

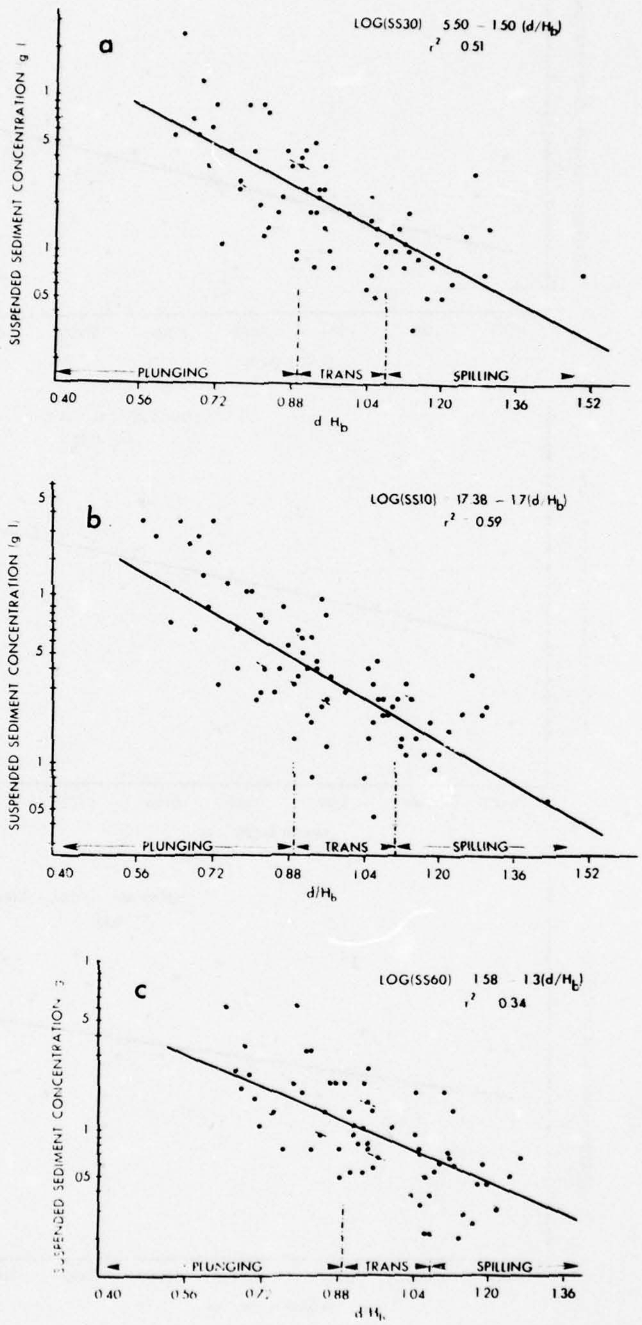


Figure 38. Mean SS10 (a), SS30 (b) and SS60 (c) vs. parameter d_b/H_b showing good separation of concentration values for the indicated breaker type ranges. Up to 60% of the variability in mean concentration is accounted for by this simple variable. The improved correlation over the results using parameter BRKER are partly due to the reduced number of mean values.

unaccounted for by this parameter, it is a continuous variable, more useful for sorting the data and obtaining correlations than a simple stepped visual classification.

In the following results, data sorting has been performed on the basis of the d_b/H_b breaker classification given in the previous section. At the discretion of the writer, a slight modification to the d_b/H_b ranges by wave type were made in order to increase the number of data points for each sample. Sorting by breaker type was performed using the following ranges:

Spilling - $d_b/H_b > 1.04$
Transition - $0.89 < d_b/H_b < 1.10$
Plunging - $d_b/H_b < 0.93$.

Thus, there was overlapping of the data with some data classified as both spilling and transition waves (d_b/H_b = 1.04-1.10) and some as plunging and transition waves (d_b/H_b = 0.89-0.93). This is deemed justified since, by definition, transition waves exhibit characteristics of each primary breaker class, and the indicated ranges maintain the distinction.

Tests of Concentration vs. Wave Process Parameters

It would be useful to establish the relationship between suspended sediment concentration and commonly measured wave parameters for purposes of prediction. The writer is unhappy to report, however, these much sought after simple relationships do not exist for these data. The following results provide some clear trends, but many relationships are, at best, ambiguous and require additional data for testing. Many of the independent variables offer little explanation for the variation in suspended sediment.

Breaker height (H_b). - Sorting the data by d_b/H_b breaker type ranges, SS10 is plotted against H_b in Figure 39. (Note: the relation between SS10, SS30, SS60 and SS100 should be apparent from preceding sections. To conserve space, only SS10 will be used in the following plots).

The data included a range of wave heights from approximately 20 to 150 cm for each breaker type. Each data point represents the mean concentration for a particular wave height (with $\pm$ 1 standard deviation indicated).

The clearest trend is, of course, the expected higher concentration values in plunging than in spilling waves. But the variation of concentration by wave height for a given breaker does not appear to follow the widely-held notion of increasing suspensions with increasing wave energy, at least for moderate swell conditions. There is a statistically significant trend of decreasing concentrations with wave height in plunging waves (Fig. 39a). Transition waves appear to attain maximum concentrations at some intermediate wave height; whereas spilling waves show the least variation with height.

It is not clear why this unexpected result occurs, but it could be due to several reasons. Smaller waves are generally of short period, located closer to the swash zone where swash uprush-backrush interactions are greatest, and suspensions are more frequent, according to Brenninkmeyer (1976b). Large waves tend to break in deeper water considerably seaward of the zone of maximum backrush. An attempt was made during the field sampling to selectively pick waves which were least affected by the backrush of the previous wave since the problem of uprush-backrush interactions introduces an additional

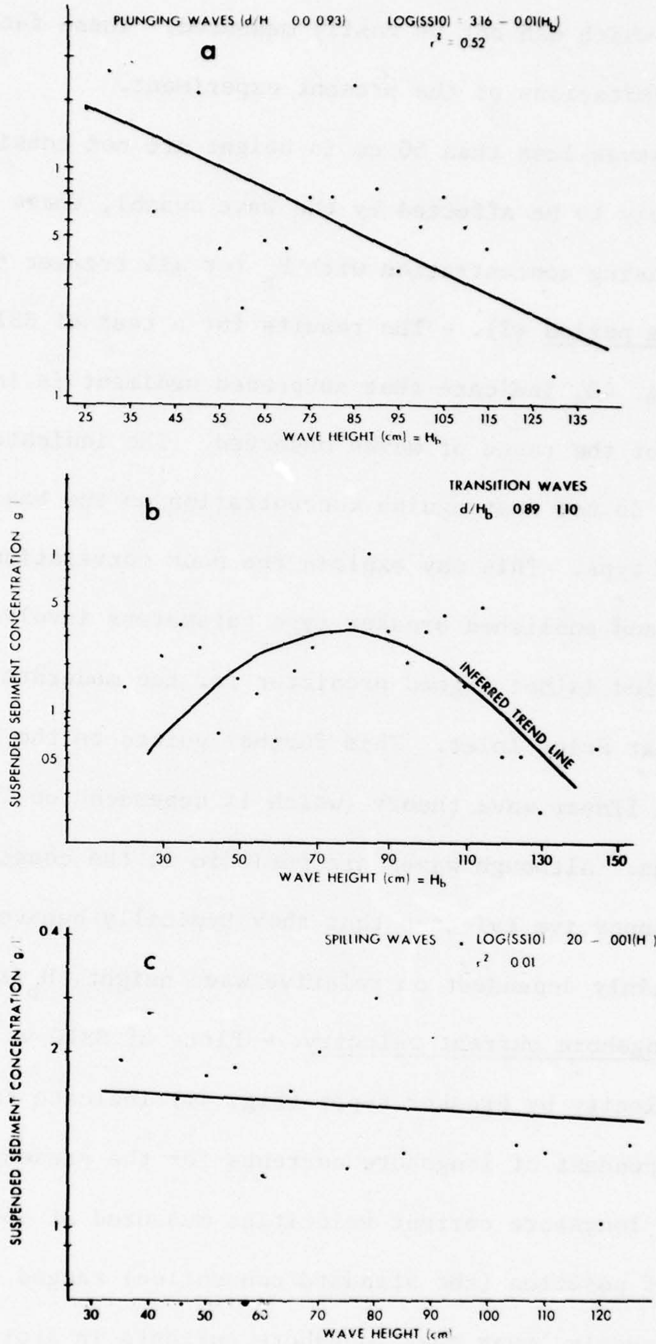


Figure 39. The variation in mean SS10 with wave height for the 3 commonly observed breaker types, plunging, $d_b/H_b > 0.93$ (a), transition (b) and spilling, $d_b/H_b > 1.04$ (c). Despite relatively low correlations, there is significant trend of decreasing concentration with wave height for plunging waves.

variable which can not be easily measured. These factors point to some of the limitations of the present experiment.

If waves less than 50 cm in height are not considered (those most likely to be affected by the wave swash), there remains a trend of decreasing concentration with H_b for all breaker types.

Wave period (T). - The results for a test of SS10 vs. T by breaker type (Fig. 40) indicate that suspended sediment is independent of wave period for the range of waves observed. The indicated trend lines are flat and do not distinguish concentration on the basis of period for any wave type. This may explain the poor correlation between concentration and published breaker type parameters involving wave steepness. Wave period is not a good predictor for the moderate swell conditions sampled at Price Inlet. This further points to the limitations of applying linear wave theory (which is dependent on T) to surf zone phenomena. Although waves are periodic at the coast, Figure 40 gives supportive evidence that they typically behave as solitary waves mainly dependent on relative wave height, H_b/d_b.

Longshore current velocity. - Plots of SS10 vs. longshore current velocity by breaker types (Fig. 41) indicate that concentration is independent of longshore currents for the present range of data. Surface longshore current velocities measured at approximately the mid-surf position (the standard convention) ranged up to 70 cm/s, significantly lower than longshore currents in storms on the South Carolina coast (Finley, 1976). While it has been shown that less force is required to suspend a particle rolling along the bed (Bagnold, 1947), this effect does not appear to be an important factor causing an increase in concentration with velocity for these data.

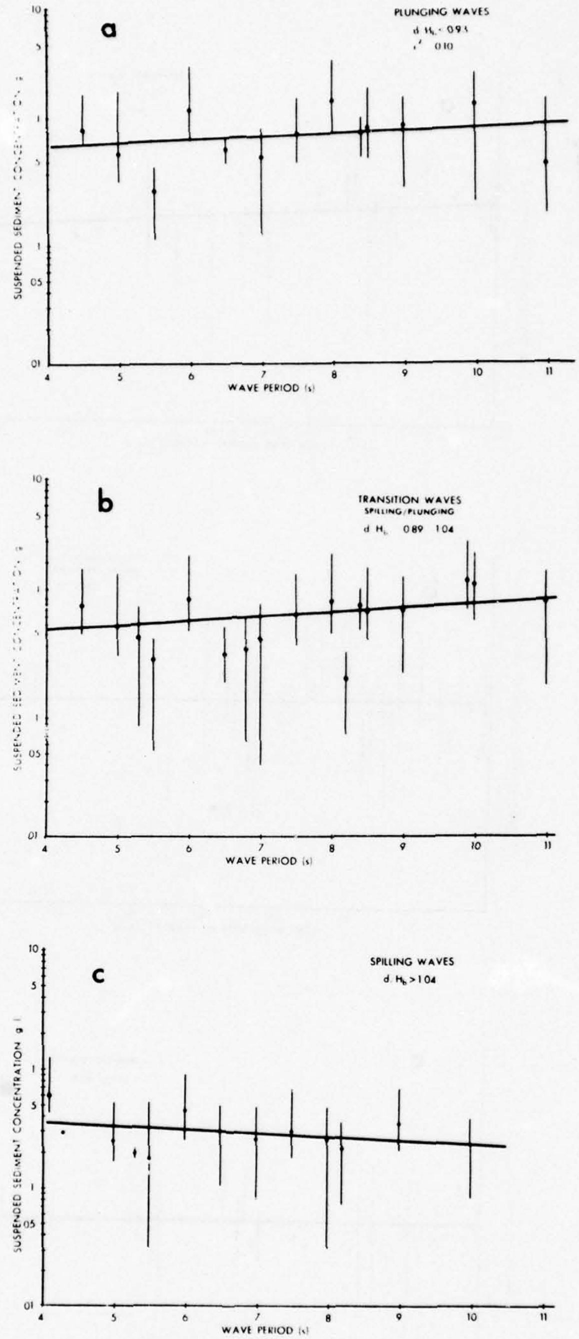


Figure 40. Mean SS10 vs. wave period for plunging (a), transition (b) and spilling (c) breakers, showing virtually no dependency between the two variables for these data collected during moderate swell conditions. Bars on the data points represent the range of concentration values to $\pm$ 1 standard deviation.

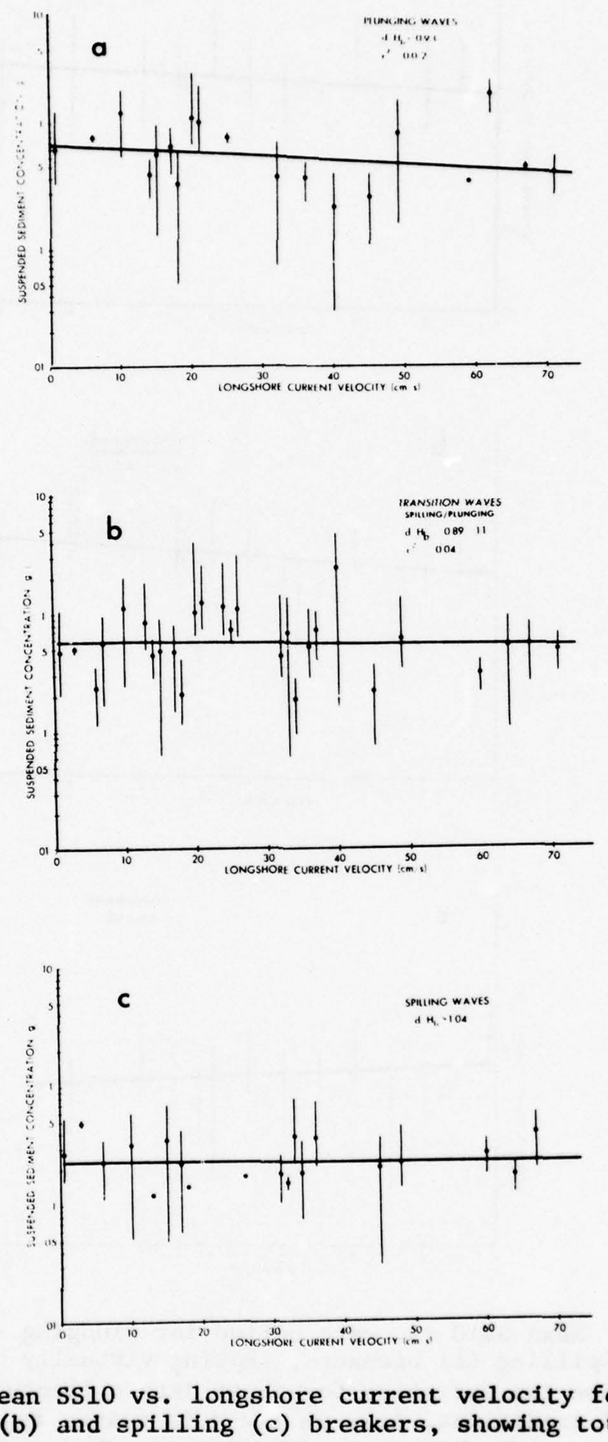


Figure 41. Mean SS10 vs. longshore current velocity for plunging (a), transition (b) and spilling (c) breakers, showing total lack of dependency between the two variables. Correlation coefficients are less than .05 in all cases.

<u>Distance from breakpoint</u>. - The distribution of suspended sediment with respect to distance from the breakpoint for each wave type is given in Figure 42. The data appear to fit the expected trend of maximum concentration within a few meters of the breakpoint. In general, sediment suspension remains at a low level of the same order of magnitude at, or seaward of, the breaker line. There is a rapid increase in concentration in the landward direction near the breakpoint, then a slow decrease toward shore. These data do not include measurements in the lower swash zone, where, according to Brenninkmeyer (1976b), sediment suspension reaches a maximum.

One interesting trend in these data is the peaked shape of the inferred distribution curve for plunging waves. Suspended sediment is higher in plunging than in spilling waves, but reaches maximum concentration values over a narrower portion of the surf zone. Spilling waves appear to attain a particular concentration level which is more or less maintained across the surf zone. This offers another line of evidence supporting the notion of variable rates of energy dissipation in different breaker types and agrees with the work of Führböter (1970).

<u>Other process variables</u>. - Similar tests of suspended sediment dependency were performed on wind velocity, tide elevation, breaker angle, and so on, but none were found to be significantly correlative (see correlation coefficients in Tables 7 and 8 in a later section).

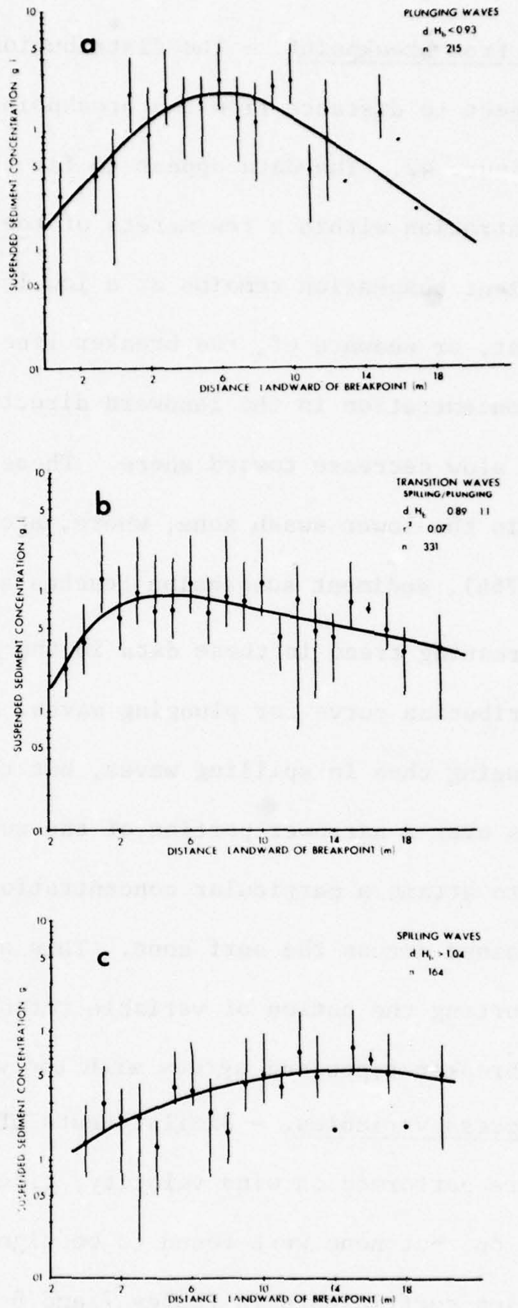


Figure 42. Inferred variation in SS10 vs. distance from the breakpoint for plunging (a), transition (b) and spilling (c) waves. In plunging and transition waves, there is a rapid increase in concentration within a few meters landward of the breaker line, then a gradual decrease in the shoreward direction. Spilling waves appear to reach a maximum concentration approximately 10 m landward of the breakpoint which is more or less maintained across much of the surf zone.

Size Distribution of Suspended Sediment

Relatively little data exists regarding the size distribution of suspended sediment in the surf zone. Fairchild (1977) has performed more size analyses on samples of suspended sediment than any other investigator and confirms the notion of decreasing grain size from bed to suspended samples from Ventnor, New Jersey and Nags Head, North Carolina (Table 4). The data of Figure 43 from Fairchild show an interesting trend of constant median grain size with nozzle (pump intake) elevation, but a general increase in size of the coarsest fraction near the bed. This reflects not only the intermittent nature of the suspension, but reduced competency with elevation above the bed.

Selected samples were sized in the present study in order to determine if there were significant variations predictable by the independent wave parameters and which, perhaps, influence the total concentration in suspension. The data presented are based on suspended sediment samples collected during the principal field study in 1977 as well as several earlier experiments in fall 1975. Table 5 gives an overall summary of grain size statistics by date, station, and elevation above the bed. Included are corresponding bottom sample sizes for the 1975 data and mean concentration values for each sample position.

<u>Size distribution with respect to sample elevation</u>. - Table 5 shows the general trend of decreasing grain size with elevation above the bed and lower sizes among suspended sediment samples compared with bed samples. Size distributions are typically coarse skewed. Figure 44 is a representative set of frequency and cumulative frequency size

Table 4. Size difference between suspended and bottom samples, obtained from a tractor mounted pump sampler (After Fairchild, 1977; p. 28).

Locality	Date	Station	Median sand size (mm) Bottom	Suspended
Nags Head,	Apr. 1964			
N. C.		320	0.30	
		285		0.22
		350	0.35	
		352		0.16
		765	0.23	
		758		0.16
Ventnor,	May 1965	Beach	0.20	
N.J.		Typical		0.13
Ventnor,	Mar. 1971	360	0.22	
N.J.		370		0.18
		375	0.22	
		375		0.19
		385	0.22	
		388		0.18

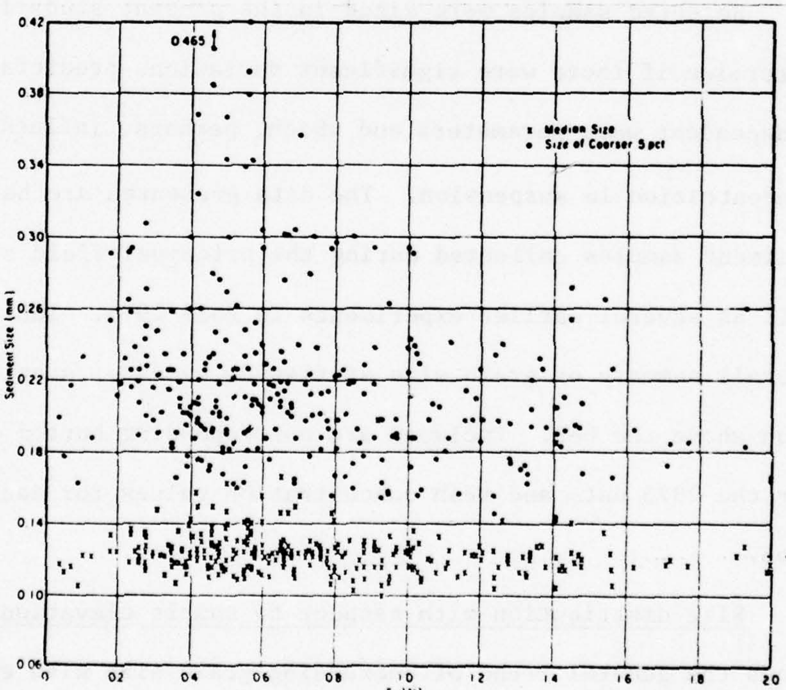


Figure 43. Median (x's) and coarse (dots) suspended sediment sizes by nozzle elevation above the bed (E) for time-averaged pump samples. Note general increase in size of the coarsest fraction near the bed. (From Fairchild, 1977; Fig. 11).

Table 5. Grain size statistics-suspended sediment and corresponding bed samples, by date, station and sample position.

1975							
Overall	m_z*(mm)	m_z*(ϕ)	σ(ϕ)	skew	kurt	Mean con. (g/l)+	n
Suspended samples	.135	2.893	.480	-.345	2.734	1.53	66
Bed samples	.153	2.735	.550	-.281	2.301	----	28
Station BU2							
SS60	.110	3.205	.514	-.783	6.118	.70	4
SS30	.099	3.337	.327	-.072	1.029	.85	7
SS10	.130	2.997	.448	-.506	3.335	3.61	11
Bed	.161	2.683	.638	-.207	2.211	----	13
Station CA1							
SS100	.145	2.780	.486	-.365	1.067	.53	1
SS60	.130	2.961	.417	-.325	2.265	.74	10
SS30	.121	3.057	.440	-.645	6.606	.91	13
SS10	.130	2.963	.438	-.254	1.234	3.40	20
Bed	.146	2.780	.473	-.426	2.379	----	15

1977							
Overall	m_z*(mm)	m_z*(ϕ)	σ(ϕ)	skew	kurt	Mean con. (g/l)+	n
Suspended samples	.110	3.190	.551	-.612	3.172	1.12	129
Station BU2							
SS60	.090	3.47	.257	-.285	-----	.55	1
SS30	.100	3.32	.524	-.630	4.037	.74	27
SS10	.109	3.20	.603	-.693	3.480	1.26	37
Bed	- not sampled -						
Station CA1							
SS60	.101	3.305	.435	-.800	5.601	.61	2
SS30	.111	3.166	.540	-.561	2.908	.76	25
SS10	.115	3.121	.536	-.517	2.110	1.47	35
Bed	- not sampled -						

* M_z = mean diameter

+These concentrations are higher than overall means for all suspended sediment concentrations because only samples with high concentrations have adequate masses for sizing using the HESA.

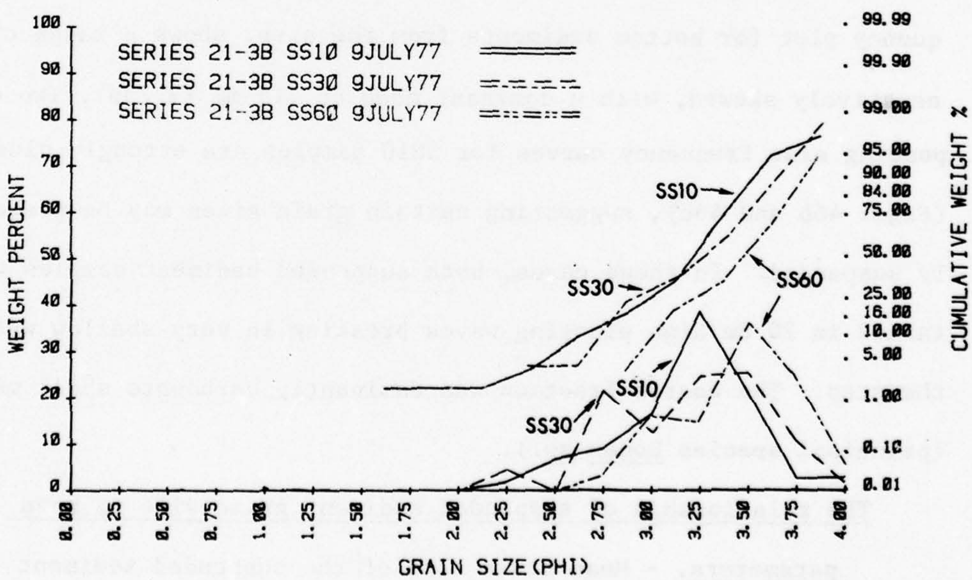


Figure 44. Example frequency and cumulation frequency size distribution curves for suspended sediment samples collected at 10, 30 and 60 cm above the bed in a single vertical array. Note general decrease in mean size with elevation. Size distributions determined from settling velocities using HESA (Anan, 1972).

distribution curves for one array of suspended sediment samples. The superimposed curves show the typical decrease in mean grain size from the sample near the bed (SS10) to the uppermost sample (SS60). A sequence of size curves in Figure 45 includes the corresponding bed sample (Fig. 45d). Note, in this particular case, the wide range of sizes on the bed, but decreasing range of sizes in suspension going up in the water column. Although this bed sample is not typical of the average size distribution along profile BU2, the widest range of grain sizes often occur at the lower beach face (step) or seaward side of the outer ridge. The location "+100-1" labeled on Figure 45d is an example from this latter location. Figure 17 shows the distribution of grain sizes at station BU2 on 20 August 1975, with the corresponding beach profile in Figure 17g.

The data also show some interesting reversals in the normal trend of negatively skewed distribution. Figure 46a, containing a size frequency plot for bottom sediments from the step, shows a range of sizes, negatively skewed, with a dominant mode at .15 mm (2.75ϕ). Two corresponding size frequency curves for SS10 samples are strongly plus skewed (Figs. 46b and 46c), suggesting certain grain sizes may be preferentially suspended. In these cases, both suspended sediment samples were obtained in 20 cm high plunging waves breaking in very shallow water at the step. The coarse fraction was dominantly carbonate shell material (principal species *Donax sp.*).

The relationship of suspended sediment grain size to wave parameters. - Mean grain size of the suspended sediment samples were sorted by wave height and breaker type to determine if

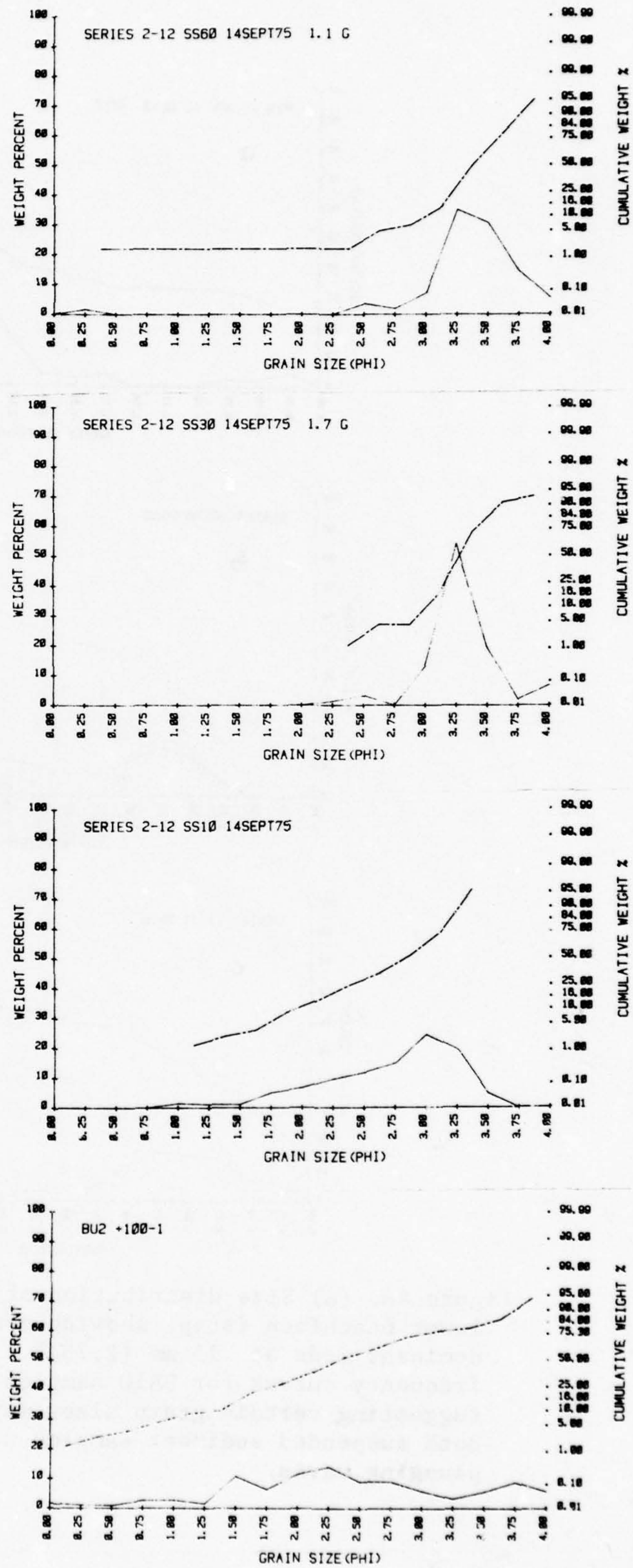


Figure 45. Grain size frequency curves for an array of suspended sediment samples and corresponding bed sample. From top to bottom, size distribution for SS60, SS30, SS10 and the bed. Note wide range of sizes on the bed at this location. The label +100-1 in (d) refers to distance in meters from a benchmark on land. The range of sizes and mean size decreases for suspended samples going up in the water column.

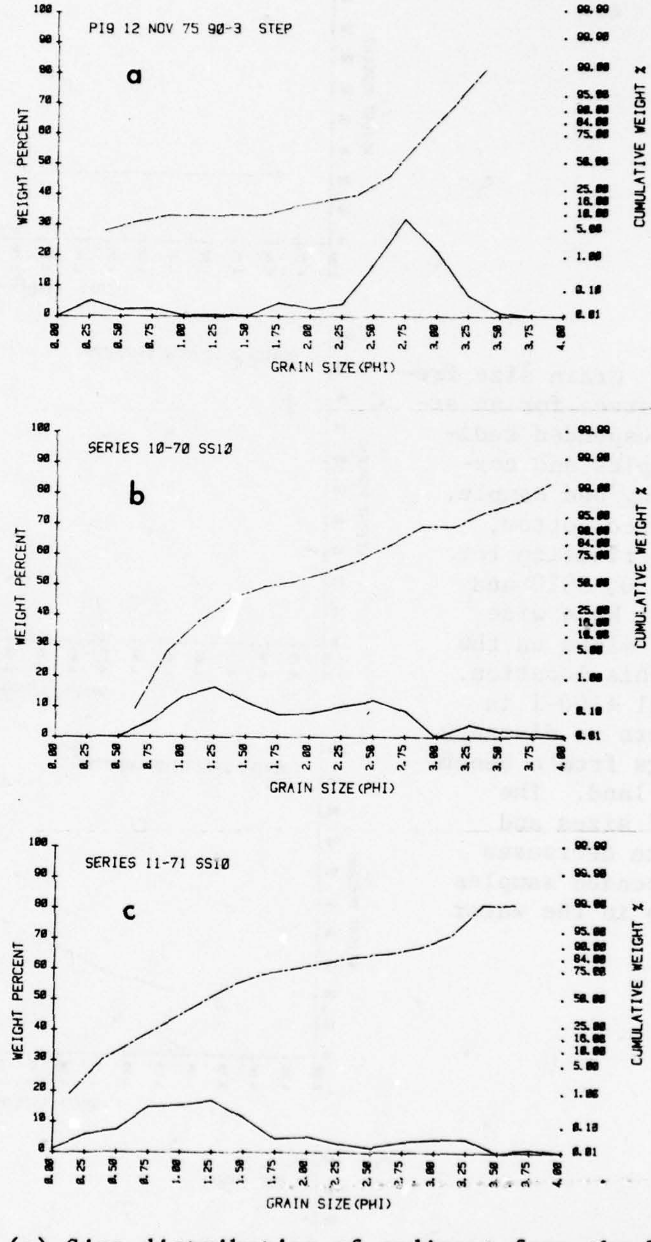


Figure 46. (a) Size distribution of sediment from the bed at the lower beachface (step) showing common negative skewness with a dominant mode at .15 mm (2.75ϕ). (b) and (c) Corresponding size frequency curves for SS10 samples which are strongly plus skewed, suggesting certain grain sizes may be preferentially suspended. Both suspended sediment samples were collected in 20 cm high plunging waves.

Table 6. Grain Size Statistics (1977) - Suspended Sediment Samples by Breaker Type and Sample Position.

Sample elevation	M_z(mm)	$M_z(\phi)$	$\sigma(\phi)$	Skew	Kurt	n
		SPILLING				
SS60	.090	3.470	.251	-.285	-0.43	1
SS30	.110	3.178	.551	-.698	2.53	4
SS10	.109	3.202	.560	-.779	4.29	10
		PLUNGING				
SS60	.101	3.305	.435	-.800	5.601	2
SS30	.105	3.258	.510	-.584	4.228	35
SS10	.113	3.147	.570	-.634	3.006	52

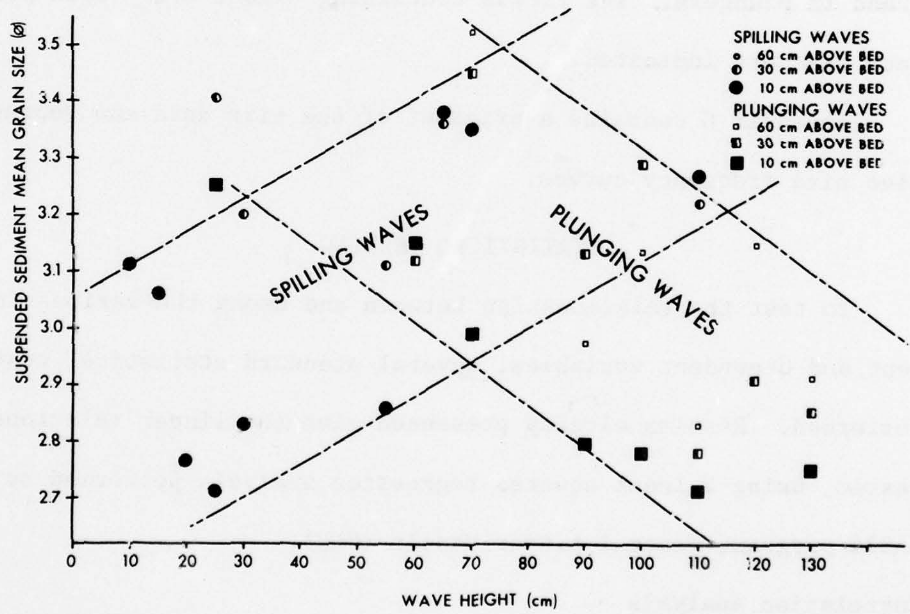


Figure 47. Mean size of suspended sediment averaged by wave height and sorted by breaker type and sample elevation. Circles represent spilling waves, and squares correspond to plungers. Symbol size decreases with sample elevation above the bed. For a given wave height, there is a consistent trend of decreasing mean size with elevation. The fields for plunging and spilling breakers containing virtually every data point are indicated. It is uncertain whether this is real or an artifact of the sampling method.

there was any dependency. The overall mean sizes by breaker type given in Table 6 do not indicate any obvious trends other than uniformity at a given sample position.

Figure 47 is a scatter plot showing mean grain sizes by sample height, wave height, and breaker type. Squares correspond to plunging waves and circles to spillers. At a given wave height, a vertical sequence of different sized squares or circles correspond to each sample elevation with the largest data points representing the SS10 samples and so on. There is an apparent trend of decreasing size with increasing wave height in spilling breakers and the reverse trend in plungers. The fields containing almost every data point for each case are indicated.

Appendix C contains a printout of the size data and representative size frequency curves.

STATISTICAL TESTING

To test the relationships between and among the various independent and dependent variables, several standard statistical tests were performed. Results already presented give the linear relationships tested, using a least squares regression analysis performed by the SAS76 program, General Linear Models (GLM).

Correlation Analysis

Correlation matrices were produced using SAS76 Procedure CORR for the principal data set of concentration values, as well as the data set of size distributions. A partial listing of each correlation matrix is given in Tables 7 and 8. The complete matrix for 408 observations is given in Appendix D. With regard to the log transformations of the dependent variables, SS10, SS30 and SS60, correlations

Table 7. Correlation coefficients - suspended sediment concentration and wave process variables for individual observations.

	SS10	SS30	SS60	d_b/H_b	H_b	d_b	m	T	V	Wind
SS10	1.000	.809	.571	-.535	-.074	-.334	.261	.106	.108	-.106
SS30		1.000	.722	-.518	-.075	-.329	.279	.087	.098	-.070
SS60			1.000	-.483	.283	-.003	.242	-.205	.385	-.021
d_b/H_b				1.000	-.251	.194	-.261	-.159	-.047	.343
H_b					1.000	.887	.056	-.051	.202	-.033
d_b						1.000	-.092	-.171	.180	.139
m							1.000	-.031	.115	.181
T								1.000	-.339	-.490
V									1.000	.539
Wind										1.000

Table 8. Correlation coefficients - suspended sediment size distributions and selected location and process variables for individual observations.

	H_b	d_b/H_b	Dist. from Brkpt.	Elev. above Bed	M_z	σ	Skew	Kurt	SS Conc.
H_b	1.000	-.162	.225	.288	.216	-.058	-.271	.166	.000
d_b/H_b		1.000	.192	.011	-.041	.090	.069	-.088	-.114
Dist.			1.000	.209	.135	.102	-.133	.028	-.001
Elev.				1.000	.190	-.141	.016	.042	-.280
M_z					1.000	-.574	-.213	.193	-.075
σ						1.000	-.359	.001	.098
Skew							1.000	-.776	-.092
Kurt								1.000	.076
SS Conc.									1.000

were highest:

1) between suspended sediment samples at different elevations (e.g. for Log (SS10) with Log (SS30), r = .809);

2) between concentration and breaker type parameters, BRKER and d_b/H_b; r = -.544 and -.535, respectively; and

3) between concentration and breaker depth (d_b) or concentration and beach slope (m); r = -.334 and .261, respectively.

Correlation coefficients between suspended sediment concentration and the independent variables wave period, longshore current velocity, and wind velocity, were all positive, but less than 0.2. Galvin's (1968) breaker parameter (B_b) shows slightly negative correlation with concentration (r = -.15). With no separation of the data by breaker type, wave height shows almost no correlation with Log (SS10) ($r < 0.01$).

The independent variables are somewhat more correlative with concentration when the data is sorted by "d_b/H_b" breaker types. For example, the correlation with wave height for plunging waves improves to r = .217, and with beach slope to r = .243.

Given the inherent variability of the data, these low coefficients are not surprising. But are they significant, or is sediment suspension in the surf zone basically a random process? Calculated against individual observations, correlations are certainly poor. But when calculated against mean concentrations obtained under similar conditions, they improve significantly.[2] A few examples of this are given in Table 9.

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[2] The means referred to are those plotted in the scatter diagrams in the preceding sections.

Table 9. Improved Correlation Coefficients using <u>Mean</u> Suspended Sediment Concentrations.

			r (means)	n	r (obs)
Log (SS10)	with	d_b/H_b	.77	72	-.53
""		BRKER	.64	165	-.41
""		m	.56	31	.26
""		H_b- spilling	.10	17	-.07
""		H_b- plunging	.72	21	-.52
""		T - plunging	.10	18	.07
""		V - transition	-.06	27	.02

Although there is little significant change in correlation between wave process parameters and concentration, with the exception of H_b in plunging waves, correlations with the breaker type parameters and beach slope are considerably improved.

Multiple Regression

The SAS76 Procedure STEPWISE was used to perform multiple regression analysis on the principal variables. Details of the method of computation are given in Barr, et al., (1976). The dependent variables tested were Log (SS10), Log (SS30) and Log (SS60). Independent variables included the breaker parameters, wave process parameters, slope and sample positioning variables. The point of the analysis is to determine which variables should most likely be included in a regression model.

The simplest form of regression analysis is the linear model between a dependent and one independent variable (the linear regression calculated for most of the scatter plots). The linear model plots as a line in space defined by the dependent variable on one axis (usually y-axis) and an independent variable on another axis (x-axis). As additional variables are added, the model assumes more dimensions. A 2-way model, with 2 independent variables, plots as a plane defined by the y, x and z axes. The number of variables determines the number of dimensions in space needed to define the model. It is generally desirable to add variables to the model as long as there is continued significant improvement in the fit of the data. This, of course, is indicated by the correlation coefficient squared (r^2), which is a measure of the percentage of variation in the data accounted for by the model.

There is no guarantee that models such as these represent real processes precisely, but they can be valuable in isolating the most important variables.

Selected results using procedure STEPWISE are given in Table 10 in terms of the best 2-way, 3-way and 4-way models calculated. As shown in the table, one independent variable (the 1st entered in each model) generally accounts for most of the variation. Succeeding variables only give slight improvement in r^2. For individual observations, less than 40% of the variation is explained by any of these models. However, when mean values of concentration (by d_b/H_b) are used (Table 10 - lower half), the model improves significantly.

There is a relatively small improvement in r^2 with increasing number of variables indicating the linear, or 2-way, models are probably the most reliable. And, not surprisingly, the key variables are the breaker type parameters, d_b/H_b and BRKER.

Table 10. Multiple regression models on dependent variable Log (SS10) (intercepts and slopes omitted)

INDIVIDUAL OBSERVATIONS OF LOG(SS10)

ALL WAVES

Model	r^2
BRKER; d_b	.378
BRKER; d_b; Distance from breakpoint (x)	.394
BRKER; d_b; X; V	.400

PLUNGING WAVES

Model	r^2
d_b; BRKER	.370
d_b; BRKER; X	.384
H_b; d_b; X; m	.393

SPILLING WAVES

Model	r^2
H_b; d_b/H_b	.044
H_b; d_b/H_b; V	.084
H_b; d_b/H_b; T; X	.094

MEAN VALUES OF LOG(SS10)

ALL WAVES

Model	r^2
d_b/H_b; d_b	.641
d_b/H_b; d_b; m	.652
d_b/H_b; H_b; d_b; m	.662

DISCUSSION

Limitations of the Data

The data presented are limited due to the relatively restricted site specific conditions of the experiment. Although there has been considerable mention of varying beach slopes and breaker type, the data is confined to gently sloping, fine-grained, densely compacted beaches. As such, it does not represent a wide spectrum of coastal morphologies or sediment grain sizes. With regard to the three underlined conditions, all are important in influencing the amount of sediment in suspension.

For example, despite some ambiguity in these data, it appears that even in a narrow range of beach slopes, concentration tends to increase with increasing slope. Data from steeper beaches at Duck, North Carolina ($\overline{m} = .05$) collected using the same techniques, yield higher mean concentrations near the breaker line (Kana and Ward, in prep.). Nummedal and Stephen (1976) measured suspended sediment concentrations two orders of magnitude higher than the Price Inlet data on Alaska beaches ($\overline{m} = .074$). Despite significant variations in wave climate, among these examples, beach slope should be considered in any general predictive model.

Two factors affect compaction of the bed: sediment grain size distribution and wave energy. Since most beaches are generally well sorted, with an absence of cohesive sediments, finer-grained beaches tend to be most densely compacted. Beaches of a given grain size show variations in bed compaction with respect to beach morphology and exposure to waves. For instance, the exposed beach face and seaward side of the inner ridge at the present study site is a smooth, compact pavement, dense enough to pull a 250 kg cart along without leaving deep tire tracks (Fig. 23). But near the inlet, where the beach is more sheltered from waves by offshore shoals, the sand is sometimes thixatropic. Obviously, these two conditions affect sediment suspension quite differently. There was no attempt in this experiment to determine the magnitude of these differences.

The data only apply to relatively featureless surf zones, essentially devoid of small scale bedforms. Although there have been several studies on the effect of bedforms on sediment suspension and transport, they have relatively little application for this experiment. Along exposed beaches in South Carolina, small-scale ripples are essentially absent from the breaker zone and were not treated as a significant variable in these data.

A final consideration which necessarily limits these data is the zone of sampling. As mentioned previously, an attempt was made to include only data collected near the breaker zone away from the swash zone.

Advantages of the Data

Waves were chosen with the intent of sampling only in well formed, easily definable breakers. This certainly biases the data in favor of swell conditions, but increases control over sampling position and wave measurements.

Other advantages of these data compared with previous, direct measurements of suspended sediment include:

1) Multiple samples to determine vertical gradients of concentration;

2) Multiple arrays to "follow" the variation in concentration in the bore of a broken wave.

3) Minimal sampler influence to the bed and relatively fast response time; and

4) Wave process measurements, of necessity, made in situ.

This last advantage gives an unusual amount of control to these data, compared with experiments utilizing remote sensing equipment. In the case of breaker measurements, remote sensing wave gauges are inadequate for determining the breakpoint or distance to the breakpoint from the sampling station. Similarly, depth at breaking at the breakpoint can only be reliably measured by an observer in situ.

The final advantage is the relatively large number of suspended sediment samples collected under similar site conditions. This is a necessity to distinguish any real trends.

Controlling Factors of Sediment Suspension

The results contained herein tend to indicate that suspended sediment in the surf zone occurs in a somewhat predictable manner given information on certain wave process variables. The data tend to confirm certain notions including the dependence of concentration on elevation above the bed and breaker type. But at the same time, they present relations which are not easily explained based on our present understanding, as, for example, an apparent decrease in concentration with wave height in plunging waves.

The range of suspended sediment concentrations found in the surf zone is at least several orders of magnitude, ranging from a few milligrams per liter to several tens of grams per liter. In terms of the distribution of concentration, the greatest fluctuation is in a vertical column. Suspensions of sand are intermittent; consequently, the variation is dependent on the elevation to which these bursts are thrown. From a statistical standpoint, the highest frequency of bursts from the bed will occur near the bed, making the mean concentration highest close to the bottom. These data show a previously observed trend of exponential decay of concentration in the vertical. Above 60 cm, sand suspensions are rare and at higher elevations, concentration tends toward some uniform wash load value composed entirely of fine-grained particles. Variability is greatest near the bed. Elevation, then, causes a natural separation of mean concentration values and can be used to sort suspended sediment samples for comparison with different sites.

For a given elevation, the most important controlling factor, based on these data, is breaker type. Plunging waves typically suspend an order more sediment than spilling waves. The relatively low concentrations characteristic of spillers suggests that relatively little sand moves by suspension; whereas plunging waves commonly exhibit bursts of coarse sediment "boiling" to the surface. This has several important implications to longshore and onshore/offshore transport which will be discussed in the last section. A partial explanation for this was given in Figure 7 (Miller, 1976), showing the distribution of air bubble concentration in spilling and plunging waves.

Figure 48, from Iverson (1952), which shows the velocity fields in spilling and plunging waves, offers more evidence for the variation in concentration by breaker type. Note in the trough preceding the crest of a plunging wave, the velocity component parallel to the bed is up to 10 times higher than in a spilling wave. This causes initial motion of the grains in a seaward direction. As the wave meets the grains, there is a sudden reversal of the current first upward toward the crest, then landward. Thus, a particle in a plunging breaker will typically describe a C-shaped trajectory as it is placed in suspension. Spilling waves, with much lower velocities in the trough, do not produce the same degree of seaward rolling along the bed. As the crest passes in a spiller, there is relatively little vertical velocity with most of the flow moving landward, parallel to the bed. The effect of this is to "push" sediment landward a short distance in brief impulses.

The other fundamental difference between the two breakers is the ratio d_b/H_b, and beach slope, m, shown in Figure 48. For waves of a given H_b, a smaller "cushion" of water exists under the plunging wave allowing proportionately more energy to reach the bed and a higher frequency of suspensions to occur.

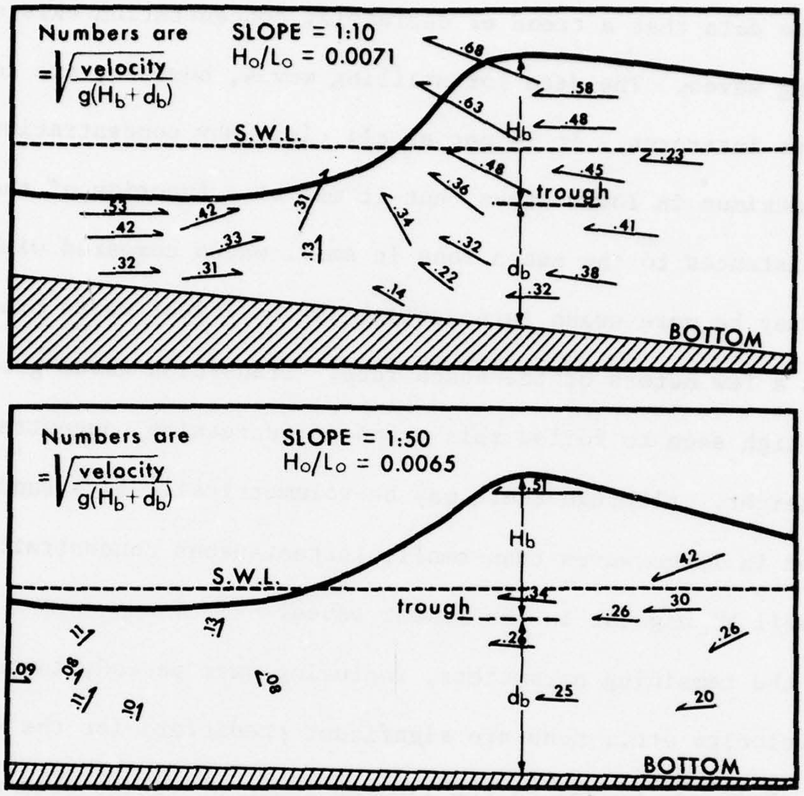

Figure 48. Relative distribution of velocity vectors in plunging (upper) and spilling (lower) breakers. Units are in terms of $(V/g(H_b + d_b))^{\frac{1}{2}}$. Note the velocity field is much stronger in plunging waves causing more rolling of sediment along the bed in both the onshore and offshore direction (Modified after Iverson, 1952).

From the results and the foregoing discussion of velocity fields in the primary breaker types, it is apparent that distance from the breakpoint is a controlling factor on the observed sediment concentrations. This seems more the case in plunging than spilling waves, based on Fig. 42a, which shows maximum concentrations peaking close to the breakpoint. Spilling waves appear to cause a slower increase in concentration in the landward direction and maintain that level across a wider portion of the surf zone. Seaward of the breaker zone, suspended sediment decreases rapidly.

With regard to increasing wave height, it's possible to conclude from the data that a trend of decreasing concentration exists for plunging waves. The data for spilling waves, however, are too scattered to interpret. It is not at all clear why concentration should be at maximum in lower waves, but it may be a function of the relative distances to the swash zone in small waves compared with large. There may be more swash interactions in the lowest waves breaking within a few meters of the beach face. Transition waves greater than 50 cm high seem to follow this trend of decreasing concentration with wave height. Although there may be volumetrically more sand in suspension in large waves than small, instantaneous concentrations may very well be highest in the lowest waves.

Of the remaining parameters, including wave period, longshore current velocity etc., none are signficant predictors for the present data. This may be due to the limited range of values obtained for most of these parameters while sampling under moderate swell conditions. Possibly, given a wider range of conditions, some additional variability would occur. But, it is unlikely that any of these remaining process variables overshadow the effect of the primary controlling factors, even under extreme conditions.

Figures 49a-e summarize what are considered to be representative general models for the distribution of concentration in the breaker zone. While these relationships can only explain up to 65% of the variability in the present data, they suggest that suspended sediment is somewhat predictable for particular site specific conditions. The parameter, d_b/H_b, has been shown to reasonably sort breaker types and accounts for most of the variability at a given sample elevation.

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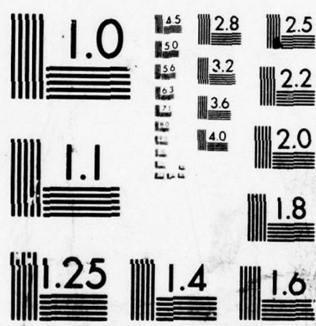

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Among these models, the one with the most uncertainty is concentration's dependency on wave height. More data are required to test whether the model proposed herein is truly applicable.

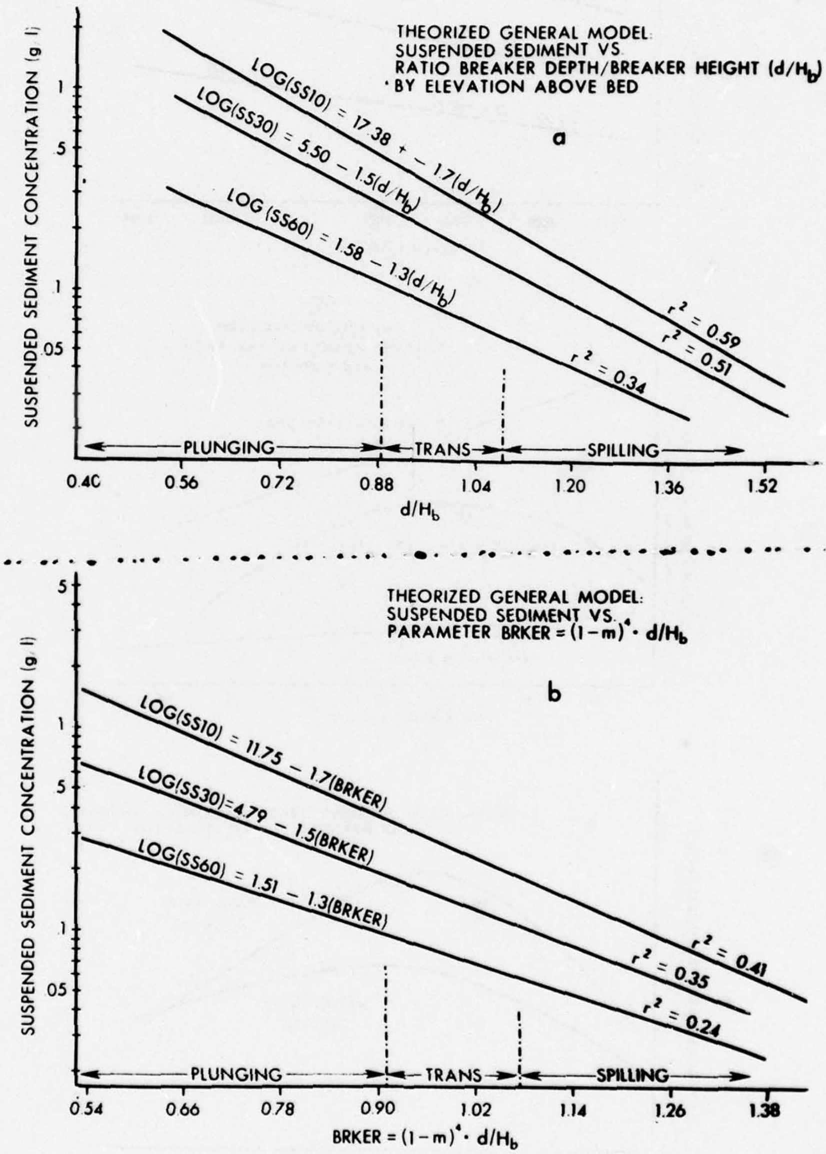

Figure 49(a andb). General linear models for the distribution of suspended sediment concentration in the breaker zone, based on the present experiment. (a) Ratio d_b/H_b by sample position and (b) Parameter BRKER by sample position.

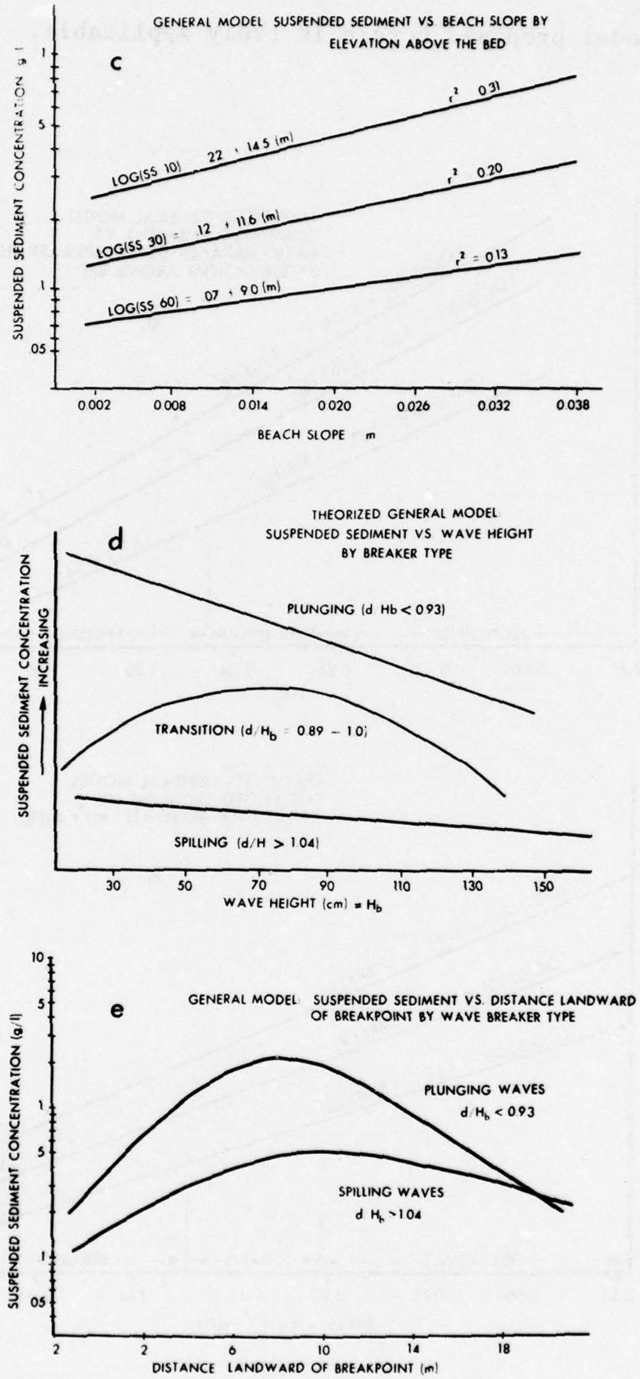

Figure 49(c, d and e). General models for the distribution of suspended sediment concentration based on: (c) beach slope (m) by sample position; (d) wave height by breaker type and (e) distance from the breakpoint by wave type.

Implication of Results

Equilibrium profiles. - These data contain some possibly significant applications to onshore/offshore sediment transport and equilibrium profiles due to the large difference in sediment suspension between spilling and plunging waves. For instance, there exists a model by Dean (1973) in which the onshore/offshore movement in the surf zone is determined by the relative height of a suspension and fall velocity of the sediment with respect to wave period. Briefly, Dean's model considers that sand is placed in suspension during wave breaking to some level, (S), which is proportional to H_b:

$$S = \beta H_b \tag{6}$$

Proportionality coefficient, β, is less than one, but of the same order. The sediment in suspension has a settling velocity, W_D, which can be combined with S to determine the time, t, required for the particle to settle to the bed, i.e.,

$$t = \frac{S}{W_D} \tag{7}$$

Assuming aymmetry of water particle motion over the wave period, sediment in suspension will follow two possible trajectories depending on whether t is less than or greater than T/2, where T is wave period. As shown in Figure 50 below from Dean (1973; Fig. 2-b), a fall time of less than T/2 results in a net onshore motion of the particle; whereas a time greater than T/2 produces a net offshore motion.

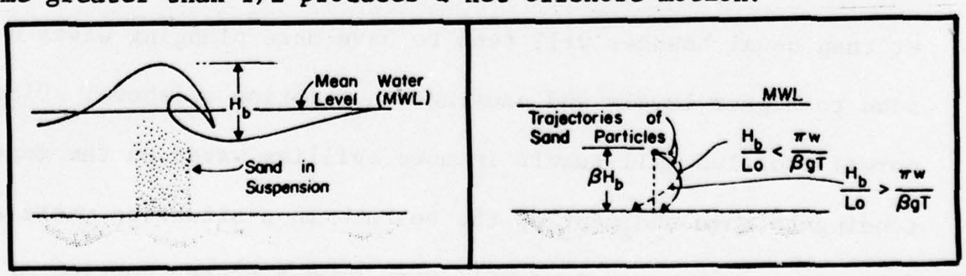

Figure 50. (left) Sediment in suspension at the time of wave breaking. (right) Two theoretical trajectories of a falling particle during the wave period (From Dean, 1973; Fig. 2).

Dean's model formulates this relationship in terms of H_b and T to predict the net movement on the basis of wave steepness. Through linear theory, he derives the following simple relations, using the above criteria to give

$$\frac{H_b}{L_o} \begin{cases} < \dfrac{\pi W_D}{\beta g t}, & \text{onshore movement} \\ > \dfrac{\pi W_D}{\beta g t}, & \text{offshore movement} \end{cases} \qquad (8)$$

where g is acceleration of gravity.

The main problem with this model is the suspension level (S) is proportional to H_b. From the present data, it is evident that d_b/H_b, not H_b alone, controls the suspension level. Instead, S should be predicted from breaker type (ie. d_b/H_b). With this criteria, plunging waves over a range of periods will suspend sediment to higher levels and likely cause net offshore movement; whereas spilling waves over a similar range of periods would suspend sand to lower levels and tend to produce net onshore movement. This can only be described qualitatively, since the velocity field is not symmetric in the surf zone.

With respect to maintenance of the equilibrium profile on beaches, onshore/offshore transport will be a function of breaker type. Steeper than usual beaches will tend to have more plunging waves entraining sand to higher levels and causing a net motion offshore. Flatter than normal profiles will result in more spilling waves on the gentle slope, tending to move sediment up the beach. In a situation where the profile is wavy, breaker type will vary from a higher portion of plungers at the steep parts (causing scour and movement in the offshore direction) to a predominance of spilling waves along the flats. As the tide rises and falls along this undulatory surface, the breaker type will undergo subtle changes in response to changing slope. The net effect will be a tendency to bring the profile back to equilibrium as sketched in Figure 51. This effect is very common along the South Carolina coast where profile changes are subtle, and the tide range (approximately 2 m) allows waves to break along a wide portion of the profile during every tidal cycle.

Applicability of solitary theory to surf problems. - It has been suggested that linear theory, in particular wave steepness, is not very useful for describing the variability in concentration or breaker type for the present data. Many long regarded notions of sediment transport are based on gross assumptions of idealized sinusoidal waves. For example, the prediction of net onshore/offshore transport from wave steepness, mentioned previously, is based on linear theory, but there is disagreement on the critical steepness value (e.g. Johnson, 1949 (H_o/L_o=0.025); King and Williams, 1949 (H_o/L_o=.012).

The waves sampled in the present experiment are best described as solitary waves, independent of period, at least for purposes of determining sediment suspension.

Importance of suspended sediment to total longshore transport. - There is some debate regarding the relative importance of suspended vs. bedload transport in the surf zone, enlivened by a recent paper by Komar (1978). The purpose here is not to debate the issue, but to offer some generalizations based on the present data. Since there is a significant difference in suspended sediment between the two principal breaker types sampled, it is appropriate to consider them separately.

Spilling waves suspend relatively little sediment, so it would be logical to assume most of the transport occurs near the bed. Plunging waves often entrain moderately high concentrations caused by numerous intermittent suspensions, so the suspension mode may dominate. But to properly evaluate the relative importance of each mode by breaker type, more has to be learned concerning relative rates of transport between these two primary breaker types.

In the opinion of this writer, the major shortcoming of models of longshore transport from wave energy flux is the lack of dependency on breaker type. There has to be a significant difference in the amount of sand transported if there exists large variations in quantities suspended with breaker type. This obviously presents more difficulties in modeling longshore transport, but it is deemed critical to improving our understanding of the relationship between wave energy and sand transport on beaches.

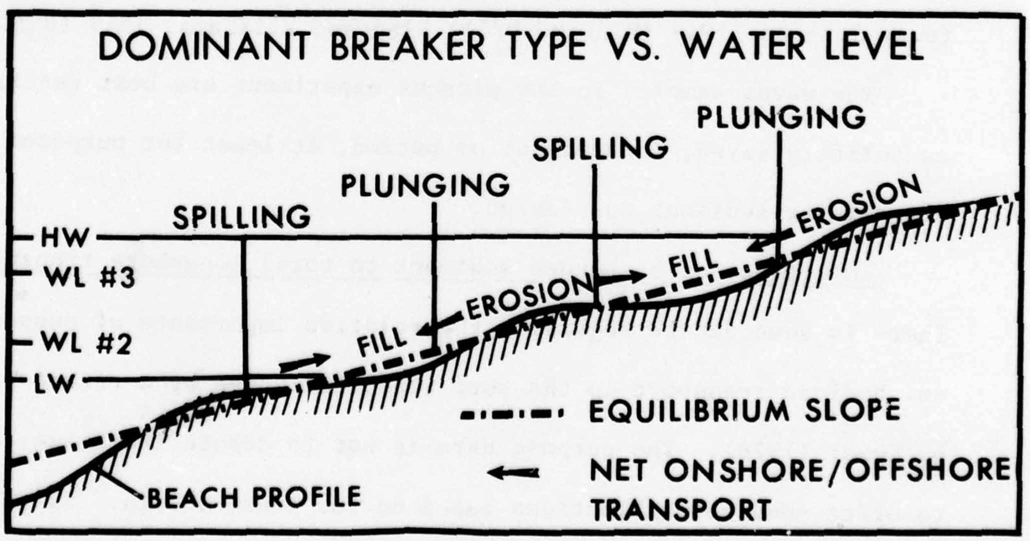

Figure 51. Hypothesized effect of breaker type variation with water level on an undulatory beach profile causing onshore transport when waves are spilling and offshore transport when waves are plunging. The net effect is to return the profile toward an equilibrium slope.

CONCLUSIONS

The data presented herein indicate that as much as 65% of the variability in mean suspended sediment concentration in the breaker zone can be accounted for with a marginal degree of certainty. It is concluded, therefore, that sediment suspension by breaking waves is not a random process.

The principal controlling factors of sediment concentration at sites similar to Price Inlet, South Carolina (gently sloping, fine-sand beaches, densely compacted) are, in order of importance:

1. Elevation above the bed.
2. Breaker type.
3. Distance relative to the breakpoint.
4. Beach slope.
5. Wave height.

Such process variables as wave period, longshore current velocity and wind velocity have little or no effect on concentration in the range of moderate swell conditions sampled.

With regard to the above, the following conclusions are offered:

1. Concentration decreases exponentially above the bottom to approximately 60 cm elevation as a function of the intermittent suspension of coarse sediment from the bed.

2. Relative breaker height (d_b/H_b) is useful for quantifying breaker types and predicting concentration at a given elevation.

3. In spilling waves, concentration gradually increases inside the breakpoint, then remains relatively constant under the bore as it propagates toward the beach. In plunging waves, concen-

tration peaks within a few meters of the breakpoint, then decreases gradually toward shore.

The final conclusion inferred from these data is that sediment transport is highly dependent on breaker type. Net offshore movement and equilibrium profiles can be qualitatively explained on the basis of variations in wave form, beach slope and suspended sediment concentration. Longshore transport rates are dependent not only on wave height, but on breaker type, which can be quantified to reasonable certainty by the simple ratio, d_b/H_b, relative wave height.

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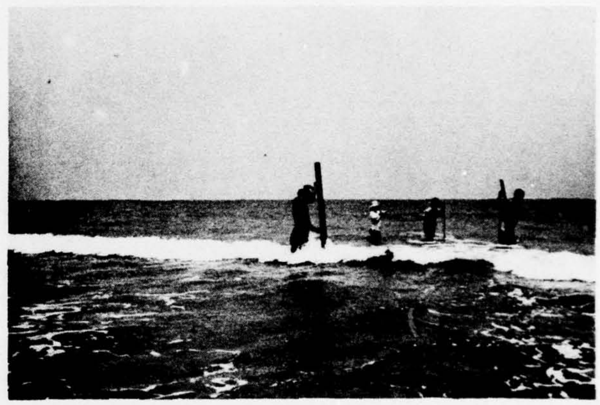
APPENDIX A - Photo Atlas of Waves Sampled and Corresponding Suspended Sediment Data; Ordered by Breaker Type and Wave Height.

Contents:



MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 40 cm
Depth at Breaking (d) 47 cm
d/H_b 1.167
n 9

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.038	3
30	0.102	8
10	0.260	9

RESULTS - THIS PHOTO SERIES 60715

H_b 40   d 50
Period 8.0 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction ----
Wind Velocity 12 mph Azimuth 205 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	1	100	
		60	
		30	0.018
		10	0.040
2	7	100	
		60	
		30	0.035
		10	0.154
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

Station PI - 1
Date 18 June, 1977
Time 1359

MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 45 cm
Depth at Breaking (d) 54 cm
d/H_b 1.202
n 11

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.076	3
30	0.112	8
10	0.238	11

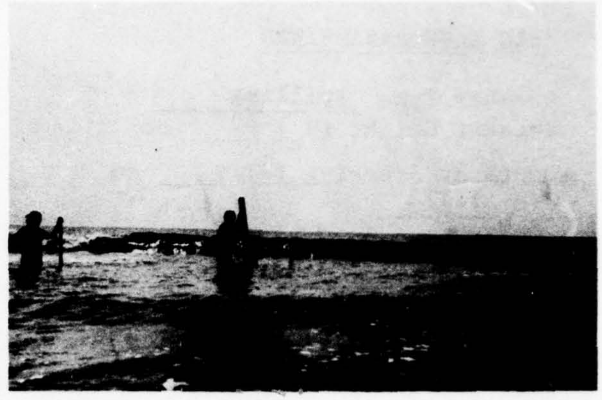
RESULTS - THIS PHOTO SERIES 60706

H_b 45 d 65
Period 6.0 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction ---
Wind Velocity 9 mph Azimuth 200 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.051
		30	0.150
		10	0.420
2	12	100	
		60	
		30	0.100
		10	0.370
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

Station PI - 1
Date 18 June, 1977
Time 1030



MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 60 cm
Depth at Breaking (d) 70 cm
d/H_b 1.172
n 14

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.033	13
30	0.083	6
10	0.169	14

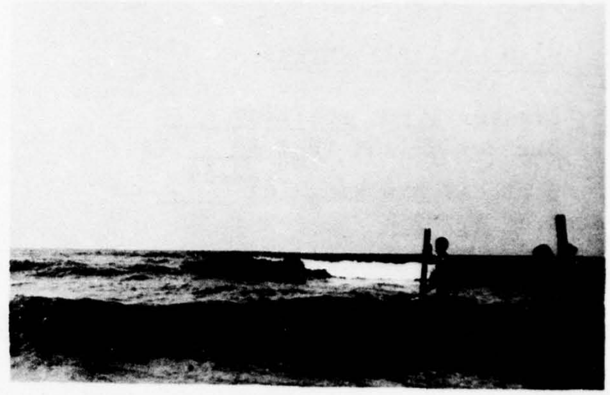
RESULTS - THIS PHOTO SERIES 60801

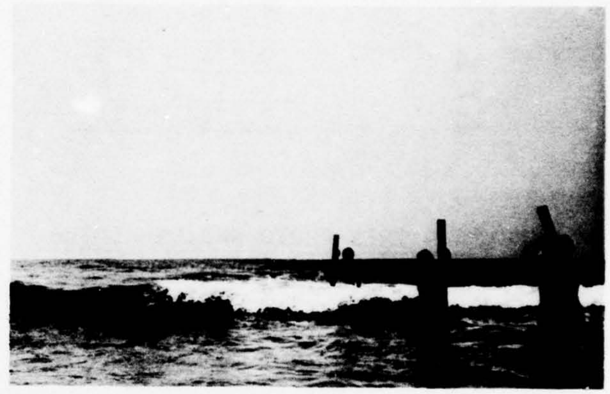
H_b 60 d 75
Period 5.5 s α_b 8 °
Longshore Current Velocity 31 cm/s
Current Direction North
Wind Velocity 11 mph Azimuth 220 °

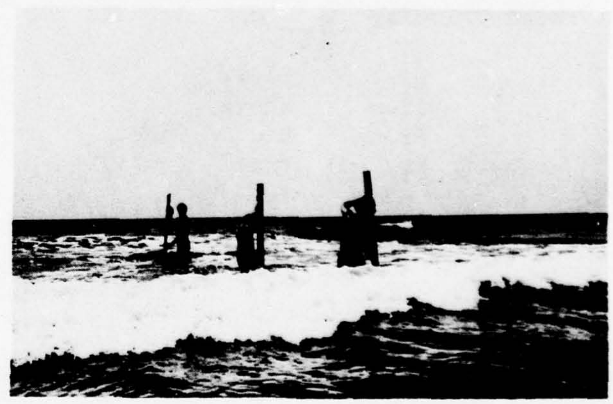
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.096
		30	0.143
		10	0.139
2	8	100	
		60	
		30	0.123
		10	0.129
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

Station BU - 2
Date 19 June, 1977
Time 1108







MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 70 cm
Depth at Breaking (d) 79 cm
d/H_b 1.133
n 7

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/1)	n
100		
60	0.026	7
30	0.027	2
10	0.289	7

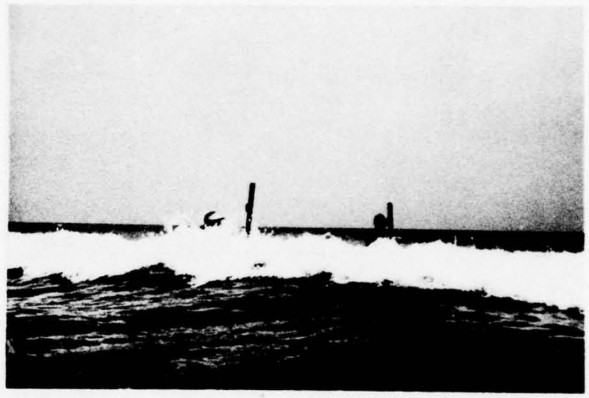
RESULTS - THIS PHOTO SERIES 60307

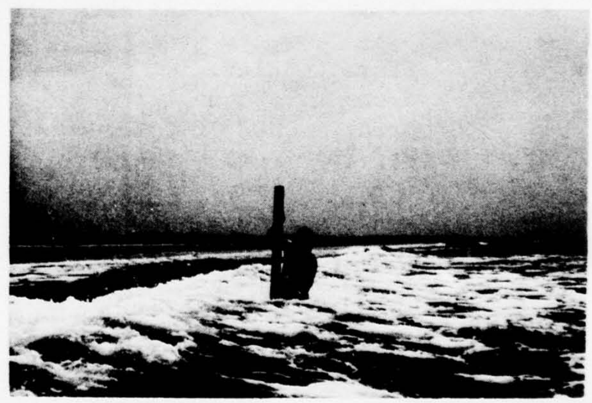
H_b 70 d 80
Period 7.0 s α_b 5 °
Longshore Current Velocity 25 cm/s
Current Direction North
Wind Velocity 4 mph Azimuth 120°

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/1)
1	3	100	
		60	0.073
		30	0.115
		10	0.264
2	3	100	
		60	
		30	0.286
		10	0.294
3	3	100	
		60	0.032
		30	
		10	0.124

PHOTOS TAKEN AT

Station PI - 1
Date 13 June, 1977
Time 1125





MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 75 cm
Depth at Breaking (d) 85 cm
d/H_b 1.133
n 5

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.040	2
30	0.060	3
10	0.154	5

RESULTS - THIS PHOTO SERIES 60511

H_b 75 d 90
Period 8.0 s α_b 6 °
Longshore Current Velocity 10 cm/s
Current Direction South
Wind Velocity 6 mph Azimuth 135 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	4	100	
		60	
		30	0.058
		10	0.052
2	7	100	
		60	
		30	0.023
		10	0.114
3	16	100	
		60	
		30	0.163
		10	0.637

PHOTOS TAKEN AT

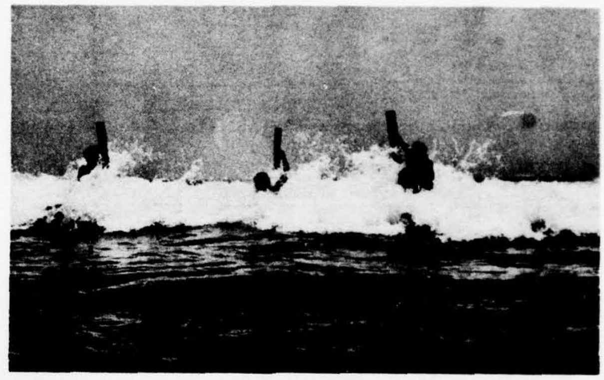
Station BU - 2
Date 15 June, 1977
Time 1410

MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 80 cm
Depth at Breaking (d) 88 cm
d/H_b 1.101
n 21

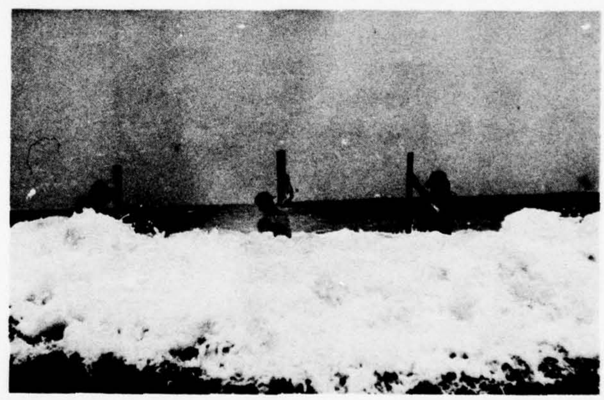
MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.098	12
30	0.151	19
10	0.369	21



RESULTS - THIS PHOTO SERIES 61110

H_b 80 d 90
Period 8.0 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction ---
Wind Velocity 4 mph Azimuth 185 °



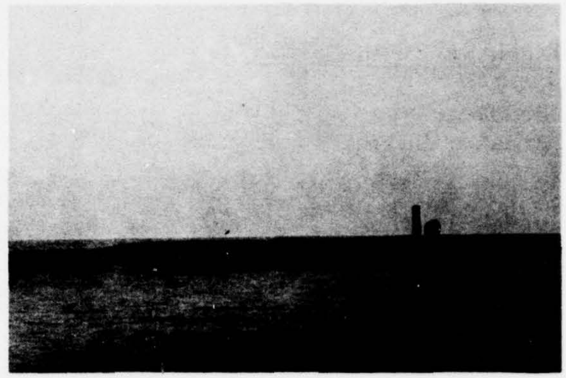
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.062
		30	0.125
		10	0.169
2	2	100	
		60	
		30	0.149
		10	0.547
3	2	100	
		60	
		30	0.141
		10	0.142

PHOTOS TAKEN AT

Station BU - 2
Date 28 June, 1977
Time 1330

MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 85 cm
Depth at Breaking (d) 94 cm
d/H_b 1.103
n 4



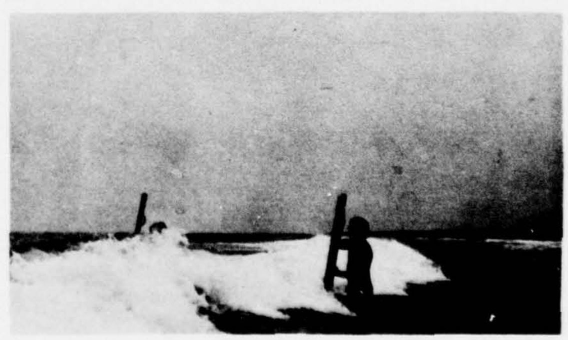
MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.074	2
30	0.121	4
10	0.448	4

RESULTS - THIS PHOTO SERIES 61708

H_b 85 d 95
Period 8.0 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction ---
Wind Velocity 4 mph Azimuth 270 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	1	100	
		60	0.147
		30	0.207
		10	0.317
2		100	
		60	
		30	
		10	
3		100	
		60	
		30	
		10	



PHOTOS TAKEN AT

Station BU-2
Date 5 July, 1977
Time 1211

MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 90 cm
Depth at Breaking (d) 99 cm
d/H_b 1.103
n 7

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.157	5
30	0.110	6
10	0.430	7

RESULTS - THIS PHOTO SERIES 61402

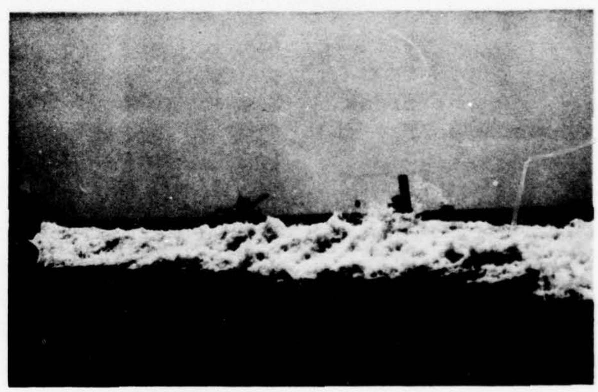
H_b 90 d 100
Period 9.0 s α_b 3 °
Longshore Current Velocity 60 cm/s
Current Direction North
Wind Velocity 13 mph Azimuth 210 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.087
		30	0.116
		10	0.176
2	7	100	
		60	
		30	0.120
		10	0.355
3	12	100	
		60	
		30	0.115
		10	0.237

PHOTOS TAKEN AT

Station BU - 2
Date 1 July, 1977
Time 1145






MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 95 cm
Depth at Breaking (d) 100 cm
d/H_b 1.053
n 10

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.375	5
30	0.215	9
10	0.511	10

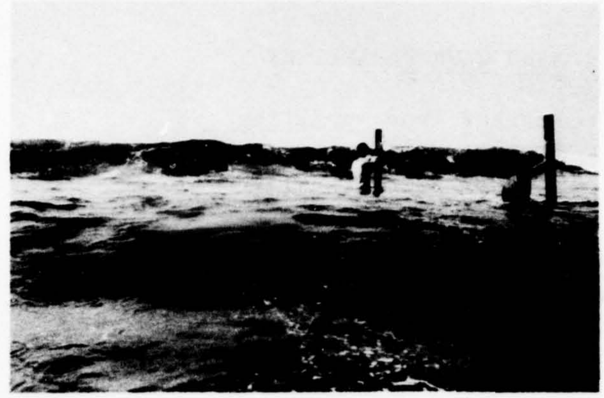
RESULTS - THIS PHOTO SERIES 60901

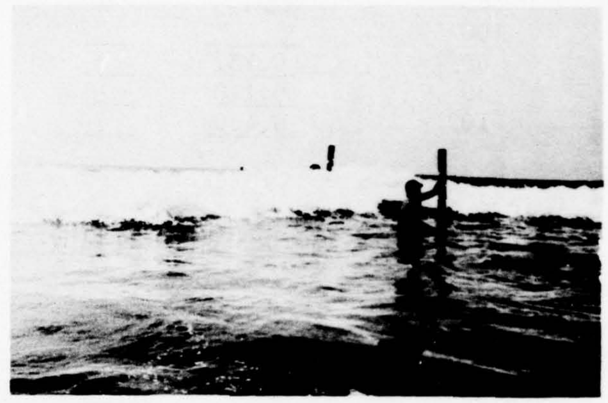
H_b 95 d 100
Period 6.5 s α_b 8 °
Longshore Current Velocity 45 cm/s
Current Direction North
Wind Velocity 7 mph Azimuth 220 °

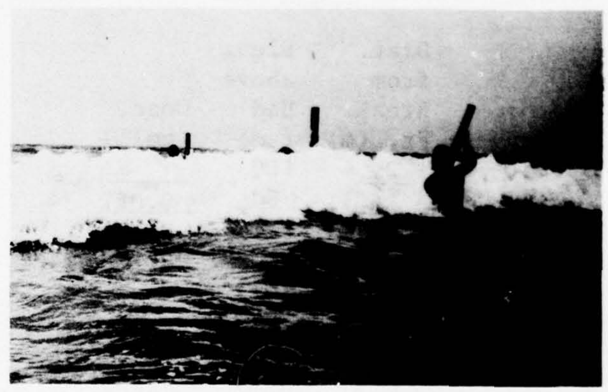
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	0	100	
		60	0.033
		30	0.043
		10	0.082
2	5	100	
		60	
		30	0.160
		10	0.387
3	10	100	
		60	
		30	0.079
		10	1.548

PHOTOS TAKEN AT

Station CA - 1
Date 20 June, 1977
Time 1012







MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 110 cm
Depth at Breaking (d) 115 cm
d/H_b 1.045
n 4

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.098	3
30	0.091	4
10	0.151	4

RESULTS - THIS PHOTO SERIES 60903

H_b 110 d 115
Period 7.0 s α_b 4 °
Longshore Current Velocity 45 cm/s
Current Direction North
Wind Velocity 7 mph Azimuth 220 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.055
		30	0.075
		10	0.089
2	9	100	
		60	
		30	0.147
		10	0.135
3	14	100	
		60	
		30	0.165
		10	0.172

PHOTOS TAKEN AT

Station CA - 1
Date 20 June, 1977
Time 1035

MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 120 cm
Depth at Breaking (d) 128 cm
d/H_b 1.063
n 4

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100	0.039	1
60	0.054	2
30	0.078	4
10	0.110	4

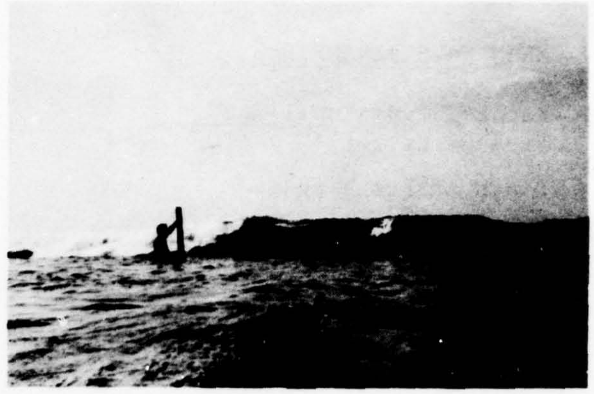
RESULTS - THIS PHOTO SERIES 60902

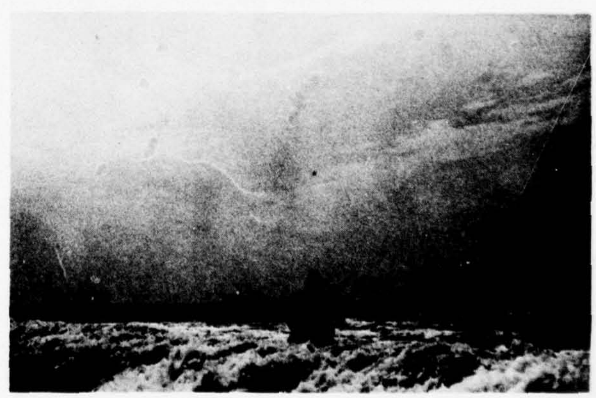
H_b 120 d 130
Period 6.5 s α_b 8 °
Longshore Current Velocity 45 cm/s
Current Direction North
Wind Velocity 7 mph Azimuth 220 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.029
		30	0.029
		10	0.069
2	7	100	
		60	
		30	0.072
		10	0.119
3	12	100	
		60	
		30	0.181
		10	0.225

PHOTOS TAKEN AT

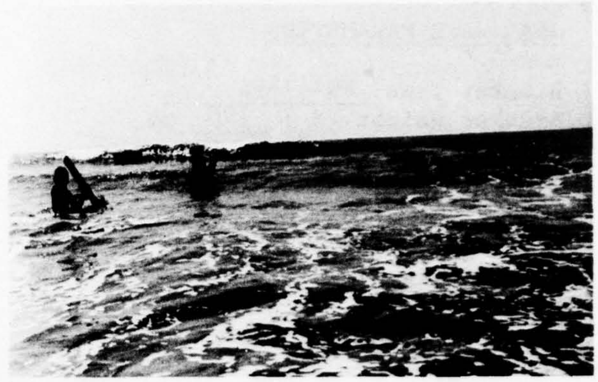
Station CA - 1
Date 20 June, 1977
Time 1023



MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 125 cm
Depth at Breaking (d) 140 cm
d/H_b 1.120
n 3

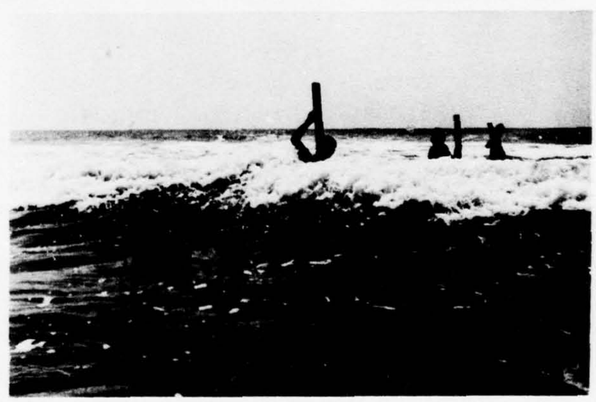


MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100	0.056	1
60	0.076	1
30	0.138	3
10	0.256	3

RESULTS - THIS PHOTO SERIES 61401

H_b 125 d 130
Period 9.0 s α_b 3 °
Longshore Current Velocity 60 cm/s
Current Direction North
Wind Velocity 13 mph Azimuth 210 °



Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	20	100	
		60	0.144
		30	0.114
		10	0.114
2	25	100	
		60	
		30	0.250
		10	0.385
3	30	100	
		60	
		30	0.149
		10	0.144

PHOTOS TAKEN AT

191

Station BU - 2
Date 1 July, 1977
Time 1120

MEAN WAVE PARAMETERS

Breaker Type spilling
Breaker Height (H_b) 140 cm
Depth at Breaking (d) 150 cm
d/H_b 1.07
n 2

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100	.084	2
60	.103	2
30	.093	2
10	.180	2

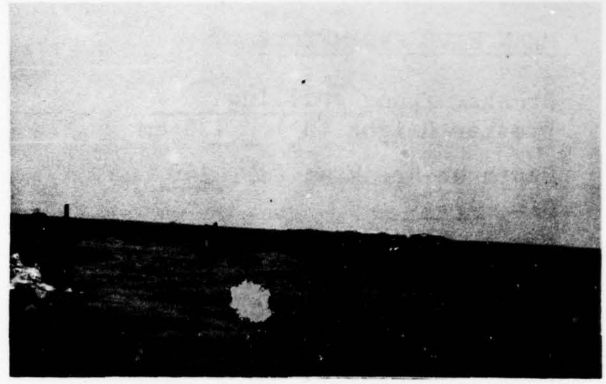
RESULTS - THIS PHOTO SERIES 61804

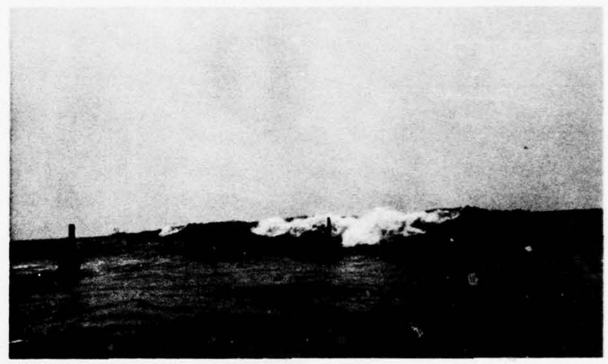
H_b 140 d 130
Period 5.0 s α_b 2 °
Longshore Current Velocity 18 cm/s
Current Direction South
Wind Velocity 10 mph Azimuth 220 °

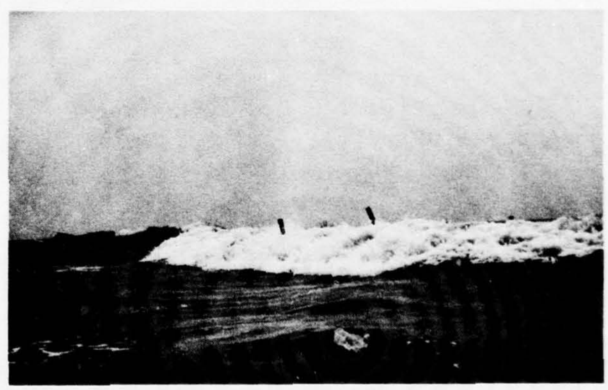
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	3	100	0.048
		60	0.075
		30	0.080
		10	0.106
2	13	100	
		60	
		30	0.202
		10	0.362
3		100	
		60	
		30	
		10	

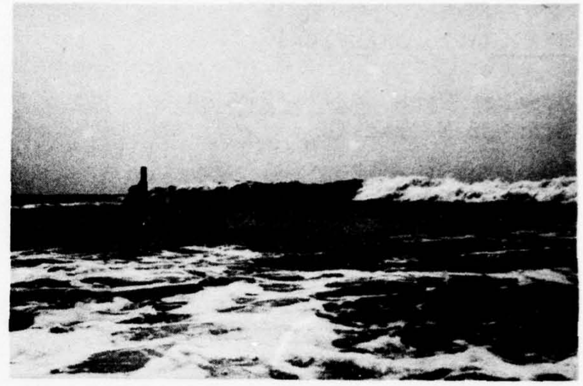
PHOTOS TAKEN AT

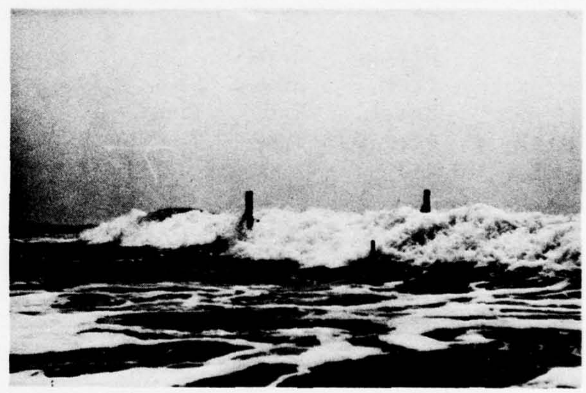
Station CA-1
Date 6 July, 1977
Time 1202

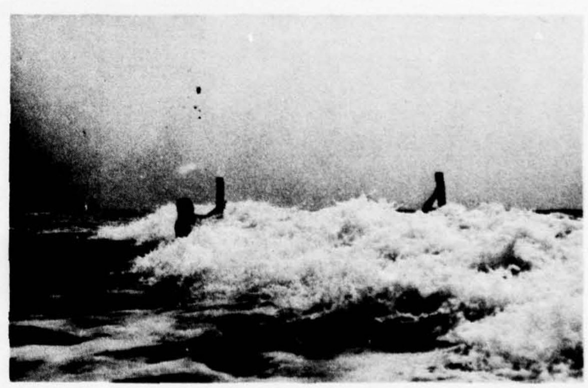












MEAN WAVE PARAMETERS

Breaker Type spilling

Breaker Height (H_b) 145 cm

Depth at Breaking (d) 150 cm

d/H_b 1.04

n 2

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100	.066	1
60	.065	2
30	.081	2
10	.209	2

RESULTS - THIS PHOTO SERIES 61902

H_b 145 d 140

Period 6.0 s α_b 5 °

Longshore Current Velocity 32 cm/s

Current Direction North

Wind Velocity 9 mph Azimuth 215 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	8	100	
		60	0.067
		30	0.084
		10	0.342
2	13	100	
		60	
		30	0.067
		10	0.061
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

Station CA-1

Date 7 July, 1977

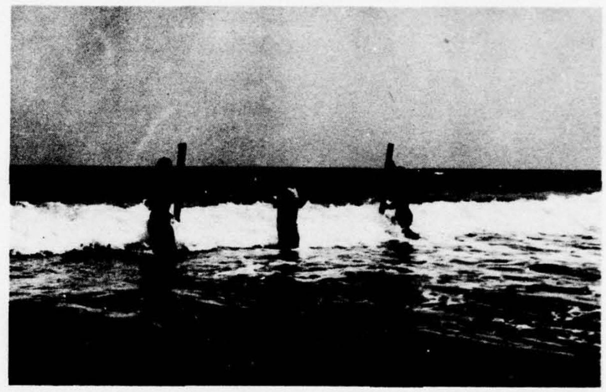
Time 1155

MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 70 cm
Depth at Breaking (d) 72 cm
d/H_b 1.02
n 50

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/1)	n
100		
60	0.115	22
30	0.460	39
10	0.781	50



RESULTS - THIS PHOTO SERIES 61115

H_b 70 d 70
Period 8.4 s α_b 3 °
Longshore Current Velocity 33 cm/s
Current Direction North
Wind Velocity 10 mph Azimuth 200 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/1)
1	3	100	
		60	0.455
		30	0.266
		10	1.134
2	3	100	
		60	
		30	0.345
		10	0.496
3	2	100	
		60	
		30	0.243
		10	0.951

PHOTOS TAKEN AT

Station BU - 2
Date 28 June, 1977
Time 1423

MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 75 cm
Depth at Breaking (d) 68 cm
d/H_b 0.910
n 26

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.166	11
30	0.380	23
10	0.780	26

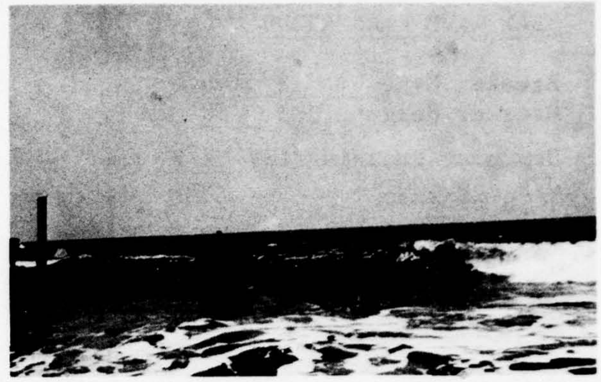
RESULTS - THIS PHOTO SERIES 61406

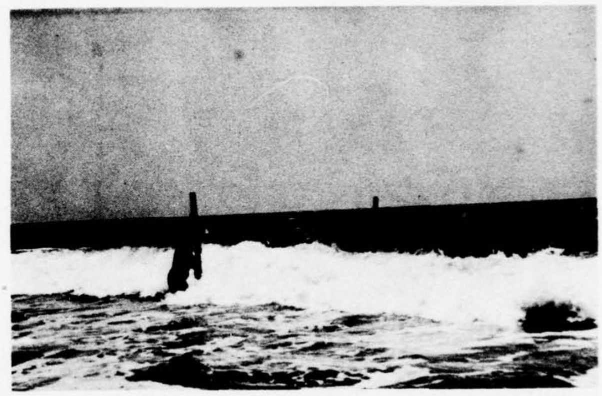
H_b 75 d 70
Period 6.0 s α_b 5 °
Longshore Current Velocity 33 cm/s
Current Direction North
Wind Velocity 18 mph Azimuth 210 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	0	100	
		60	0.334
		30	0.592
		10	0.698
2	5	100	
		60	
		30	0.837
		10	1.248
3	9	100	
		60	
		30	0.799
		10	0.982

PHOTOS TAKEN AT

Station BU-2
Date 1 July, 1977
Time 1330





MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 80 cm
Depth at Breaking (d) 74 cm
d/H_b 0.924
n 57

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.166	29
30	0.380	51
10	1.018	57

RESULTS - THIS PHOTO SERIES 60309

H_b 80 d 75
Period 6.0 s α_b 5 ^{o}
Longshore Current Velocity 37 cm/s
Current Direction North
Wind Velocity 4 mph Azimuth 120^o

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	5	100	
		60	0.137
		30	0.476
		10	0.820
2	5	100	
		60	
		30	0.372
		10	0.489
3	5	100	
		60	0.079
		30	
		10	0.141

PHOTOS TAKEN AT

Station PI - 1
Date 13 June, 1977
Time 1153

MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 90 cm
Depth at Breaking (d) 83 cm
d/H_b 0.922
n 57

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.173	28
30	0.342	52
10	0.777	57

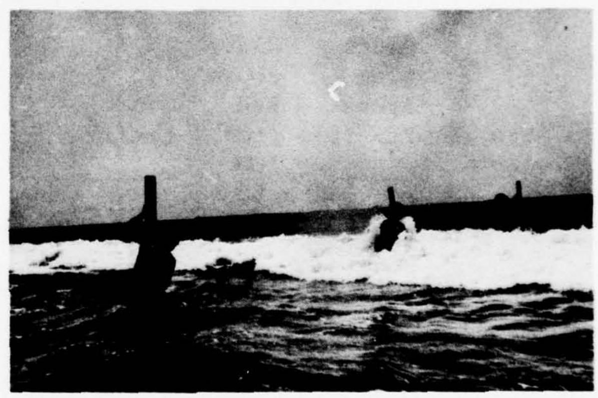
RESULTS - THIS PHOTO SERIES 61404

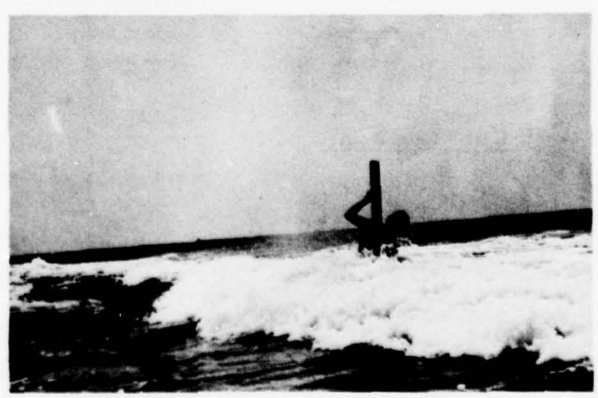
H_b 90 d 85
Period 7.0 s α_b 3 °
Longshore Current Velocity 10 cm/s
Current Direction North
Wind Velocity 13 mph Azimuth 210 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.009
		30	0.606
		10	0.565
2	7	100	
		60	
		30	0.555
		10	0.688
3	12	100	
		60	
		30	0.580
		10	0.604

PHOTOS TAKEN AT

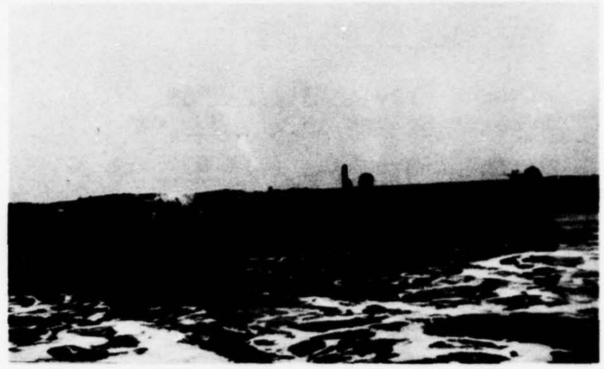
Station BU - 2
Date 1 July, 1977
Time 1220





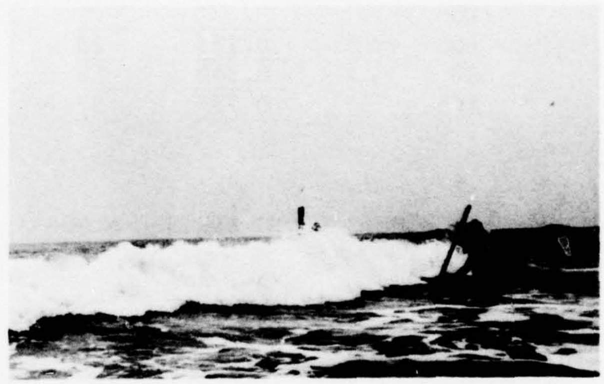
MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 95 cm
Depth at Breaking (d) 91 cm
d/H_b 0.961
n 31



MEAN SUSPENDED SEDIMENT

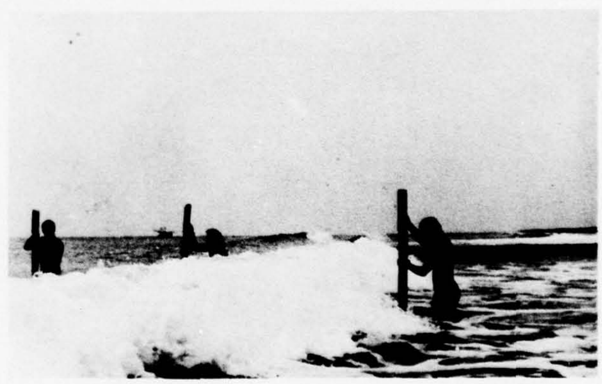
Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.240	14
30	0.325	30
10	0.550	31



RESULTS - THIS PHOTO SERIES 61707

H_b 95 d 85
Period 7.5 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction 0
Wind Velocity 4 mph Azimuth 270 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.080
		30	0.085
		10	0.127
2	4	100	
		60	
		30	0.131
		10	0.143
3		100	
		60	
		30	
		10	

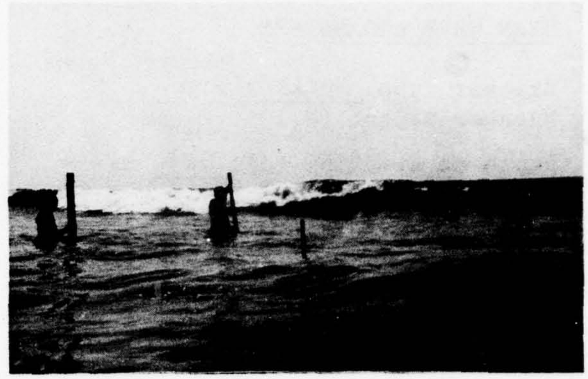


PHOTOS TAKEN AT

Station BU-2
Date 5 July, 1977
Time 1105

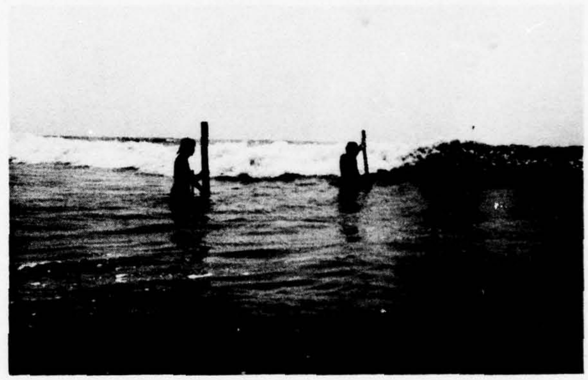
MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 105 cm
Depth at Breaking (d) 103 cm
d/H_b 0.976
n 6



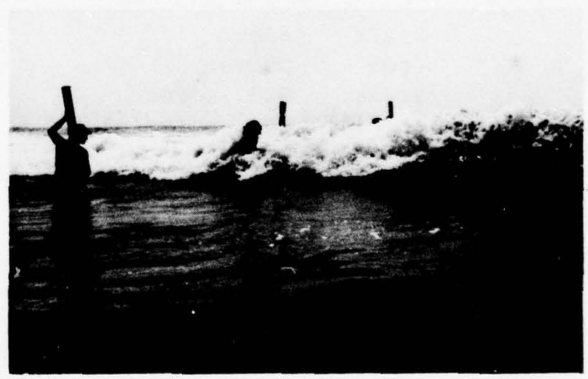
MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100	0.051	1
60	0.100	3
30	0.425	6
10	0.998	6



RESULTS - THIS PHOTO SERIES 61901

H_b 105 d 100
Period 6.0 s α_b 5 °
Longshore Current Velocity 32 cm/s
Current Direction North
Wind Velocity 9 mph Azimuth 215 °



Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	3	100	
		60	0.079
		30	0.165
		10	1.381
2	8	100	
		60	
		30	1.452
		10	3.224
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

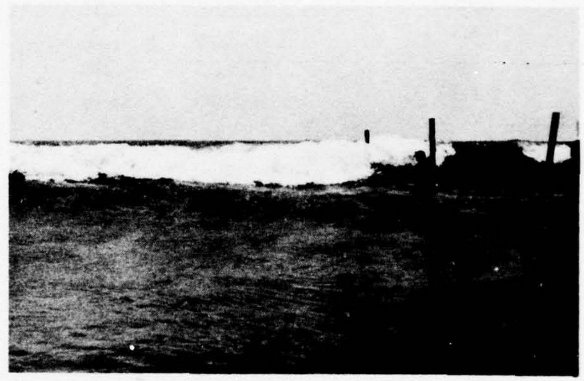
Station CA-1
Date 7 July, 1977
Time 1145

MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 115 cm
Depth at Breaking (d) 103 cm
d/H_b 0.899
n 9

MEAN SUSPENDED SEDIMENT

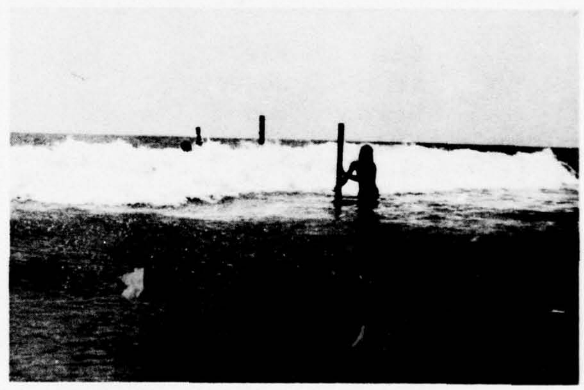
Sample Elev. (cm)	Conc. (gm/l)	n
100	0.090	2
60	0.115	3
30	0.219	9
10	0.819	9



RESULTS - THIS PHOTO SERIES 61807

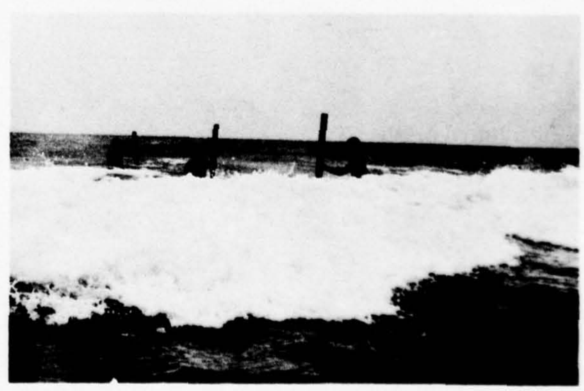
H_b 115 d 105
Period 4.5 s α_b 2 $^\circ$
Longshore Current Velocity 18 cm/s
Current Direction South
Wind Velocity 13 mph Azimuth 220 $^\circ$

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	0	100	0.161
		60	0.198
		30	0.213
		10	0.246
2	4	100	
		60	
		30	0.595
		10	0.709
3	8	100	
		60	
		30	0.337
		10	0.507



PHOTOS TAKEN AT

Station CA-1
Date 6 July, 1977
Time



MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 25 cm
Depth at Breaking (d) 19 cm
d/H_b 0.775
n 8

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60		
30	0.722	3
10	2.227	8

RESULTS - THIS PHOTO SERIES 61108

H_b 25 d 20
Period 6.0 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction ---
Wind Velocity 4 mph Azimuth 270 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	0	100	
		60	
		30	0.543
		10	1.469
2	3	100	
		60	
		30	
		10	2.592
3	6	100	
		60	
		30	
		10	6.154

131

PHOTOS TAKEN AT

Station BU - 2
Date 28 June, 1977
Time 1207

MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 45 cm
Depth at Breaking (d) 30 cm
d/H_b 0.667
n 2

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/1)	n
100		
60		
30	2.574	2
10	7.497	2

RESULTS - THIS PHOTO SERIES 60504

H_b 45 d 30
Period 7.5 s α_b 2 °
Longshore Current Velocity 10 cm/s
Current Direction South
Wind Velocity 2 mph Azimuth 330 °

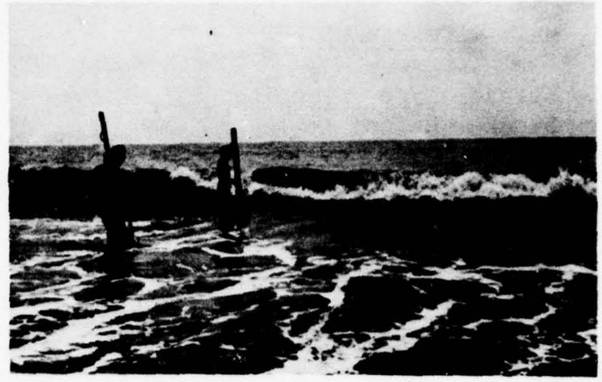
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/1)
1	3	100	
		60	
		30	3.121
		10	9.215
2	3	100	
		60	
		30	2.026
		10	5.778
3	3	100	
		60	
		30	10.221
		10	19.161

PHOTOS TAKEN AT

Station BU - 2
Date 15 June, 1977
Time 1150

MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 70 cm
Depth at Breaking (d) 58 cm
d/H_b 0.826
n 43



MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.156	15
30	0.500	37
10	0.861	43

RESULTS - THIS PHOTO SERIES 61308

H_b 70 d 55
Period 6.0 s α_b 5 °
Longshore Current Velocity 24 cm/s
Current Direction North
Wind Velocity 7 mph Azimuth 240°

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.398
		30	1.603
		10	0.886
2	9	100	
		60	
		30	2.255
		10	3.292
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

Station CA - 1
Date 30 June, 1977
Time 1258

MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 80 cm
Depth at Breaking (d) 65 cm
d/H_b 0.811
n 34

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.220	16
30	0.541	30
10	1.441	34

RESULTS - THIS PHOTO SERIES 61212

H_b 80 d 55
Period 7.2 s α_b 6 °
Longshore Current Velocity 40 cm/s
Current Direction North
Wind Velocity 14 mph Azimuth 270 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	1	100	
		60	0.323
		30	1.520
		10	7.519
2	3	100	
		60	
		30	1.243
		10	4.378
3	5	100	
		60	
		30	0.719
		10	0.600

PHOTOS TAKEN AT

Station CA - 1
Date 29 June, 1977
Time 1235

MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 80 cm
Depth at Breaking (d) 65 cm
d/H_b 0.811
n 34

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.220	16
30	0.542	30
10	1.441	34

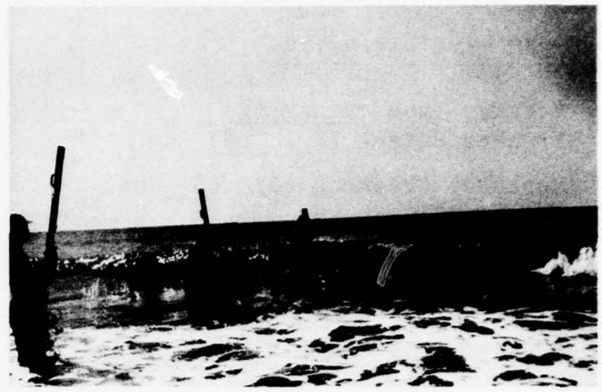
RESULTS - THIS PHOTO SERIES 61206

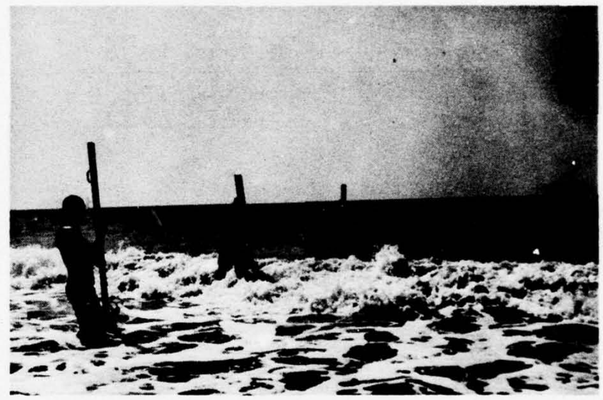
H_b 80 d 55
Period 8.0 s α_b 10 °
Longshore Current Velocity 40 cm/s
Current Direction North
Wind Velocity 5 mph Azimuth 260°

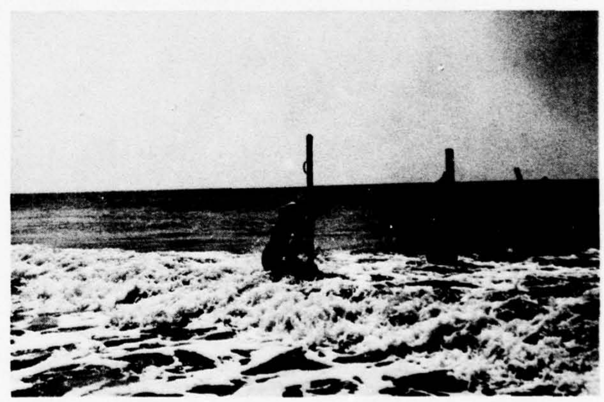
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	0	100	
		60	0.113
		30	0.509
		10	0.187
2	4	100	
		60	
		30	0.928
		10	0.187
3	8	100	
		60	
		30	1.472
		10	1.599

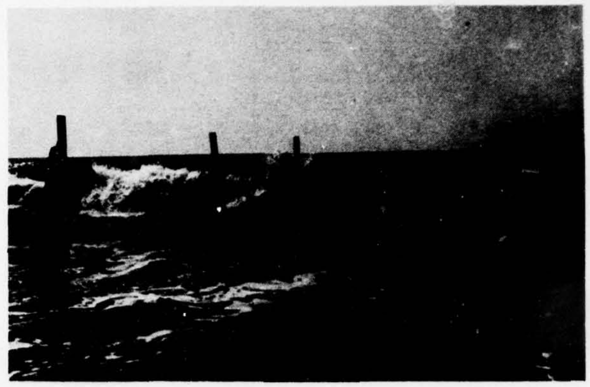
PHOTOS TAKEN AT

Station CA - 1
Date 29 June, 1977
Time 1042









MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 85 cm
Depth at Breaking (d) 60 cm
d/H_b 0.701
n 13

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.305	6
30	1.021	10
10	3.285	13

RESULTS - THIS PHOTO SERIES 61205

H_b 85 d 60
Period 8.0 s α_b 10 ^{o}
Longshore Current Velocity 40 cm/s
Current Direction North
Wind Velocity 5 mph Azimuth 260 ^{o}

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	0	100	
		60	0.116
		30	0.080
		10	0.254
2	3	100	
		60	
		30	0.274
		10	1.138
3	10	100	
		60	
		30	1.084
		10	3.323

PHOTOS TAKEN AT

Station CA - 1
Date 29 June, 1977
Time 1030

MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 85 cm
Depth at Breaking (d) 60 cm
d/H_b 0.701
n 13

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.305	6
30	1.021	10
10	3.285	13

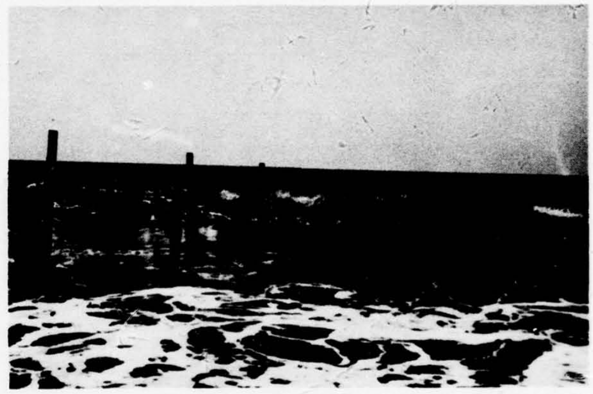
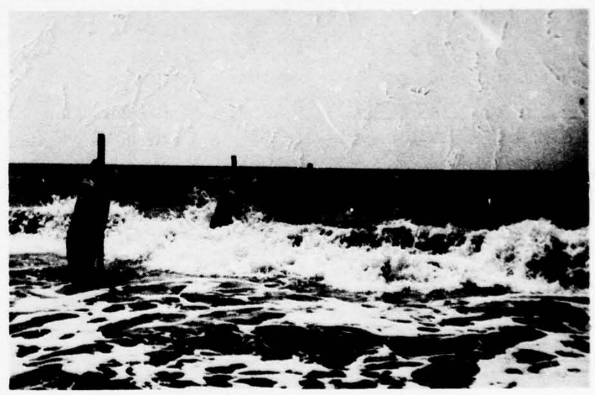
RESULTS - THIS PHOTO SERIES 61209

H_b 85 d 55
Period 8.0 s α_b 10 °
Longshore Current Velocity 40 cm/s
Current Direction North
Wind Velocity 5 mph Azimuth 260 °

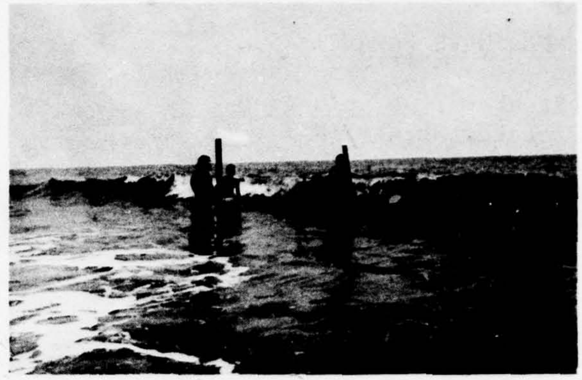
Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	1	100	
		60	0.513
		30	2.098
		10	6.690
2	4	100	
		60	
		30	2.875
		10	6.519
3	7	100	
		60	
		30	
		10	1.141

PHOTOS TAKEN AT

Station CA - 1
Date 29 June, 1977
Time 1125

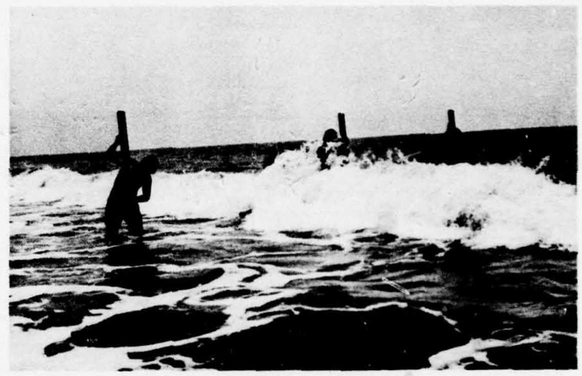

MEAN WAVE PARAMETERS



Breaker Type plunging
Breaker Height (H_b) 90 cm
Depth at Breaking (d) 74 cm
d/H_b 0.822
n 24

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.228	11
30	0.486	20
10	1.277	24



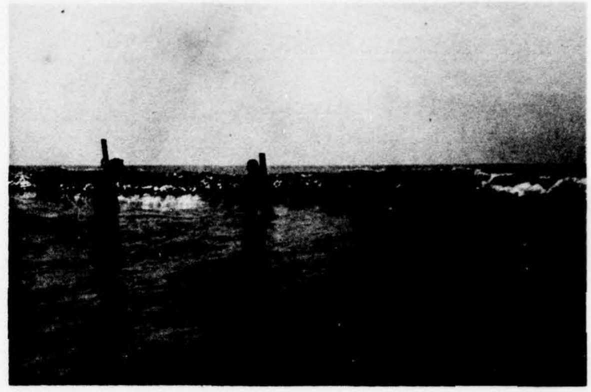
RESULTS - THIS PHOTO SERIES 61508

H_b 90 d 60
Period 10.0 s α_b 4 °
Longshore Current Velocity 21 cm/s
Current Direction North
Wind Velocity 4 mph Azimuth 230 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.261
		30	0.289
		10	2.248
2	4	100	
		60	
		30	0.738
		10	3.036
3	7	100	
		60	
		30	1.680
		10	2.218

PHOTOS TAKEN AT

Station CA-1
Date 2 July, 1977
Time 1409

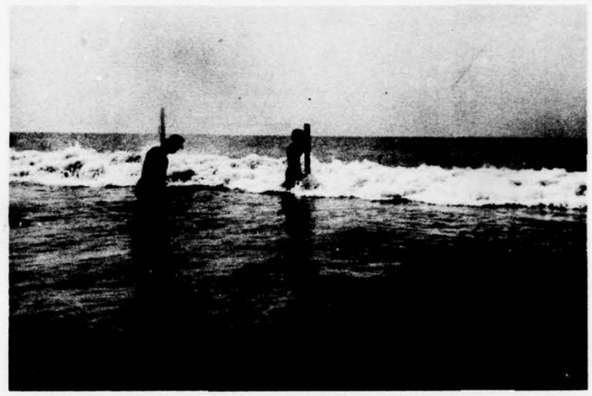


MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 90 cm
Depth at Breaking (d) 74 cm
d/H_b 0.822
n 24

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.228	11
30	0.486	20
10	1.277	24



RESULTS -- THIS PHOTO SERIES 61303

H_b 90 d 80
Period 8.0 s α_b 4 °
Longshore Current Velocity 26 cm/s
Current Direction North
Wind Velocity 7 mph Azimuth 240 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	5	100	
		60	0.057
		30	0.081
		10	0.320
2	16	100	
		60	
		30	0.359
		10	0.797
3		100	
		60	
		30	
		10	

PHOTOS TAKEN AT

Station CA - 1
Date 30 June, 1977
Time 1103

MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 95 cm
Depth at Breaking (d) 78 cm
d/H_b 0.816
n 8

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100		
60	0.130	3
30	0.549	8
10	0.837	8

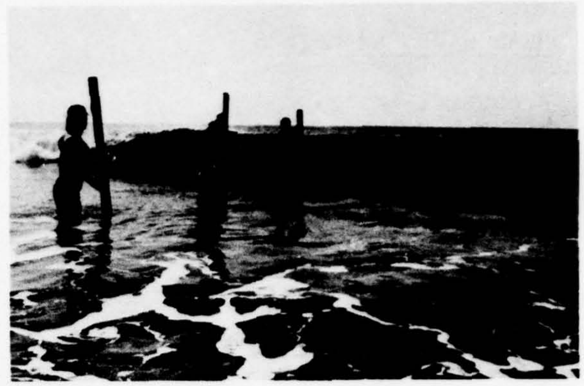
RESULTS - THIS PHOTO SERIES 61204

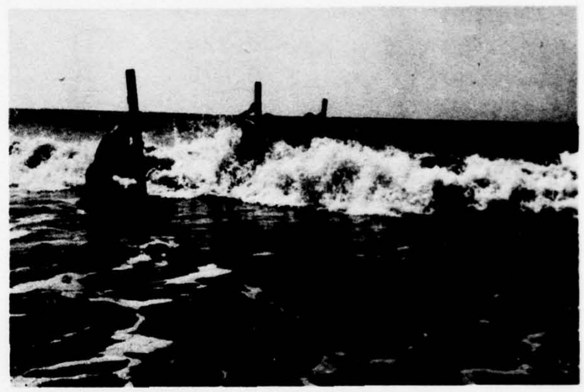
H_b 95 d 65
Period 8.0 s α_b 10 °
Longshore Current Velocity 40 cm/s
Current Direction North
Wind Velocity 5 mph Azimuth 260 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	1	100	
		60	0.170
		30	2.802
		10	3.382
2	5	100	
		60	
		30	0.113
		10	0.103
3	8	100	
		60	
		30	0.502
		10	0.873

PHOTOS TAKEN AT

Station CA - 1
Date 29 June, 1977
Time 1015



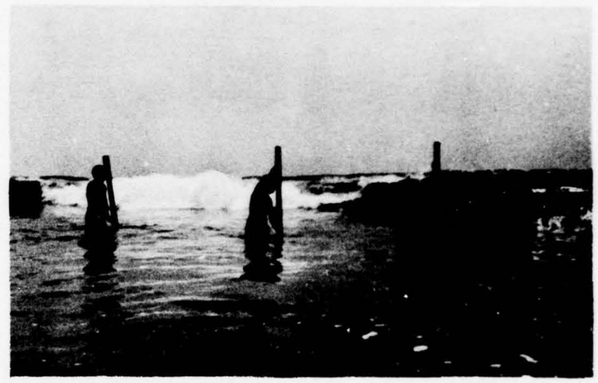


MEAN WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 100 cm
Depth at Breaking (d) 85 cm
d/H_b 0.845
n 11

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/1)	n
100	0.110	1
60	0.267	4
30	0.492	11
10	0.873	9



RESULTS - THIS PHOTO SERIES 61506

H_b 100 d 90
Period 9.0 s α_b 4 $^{\circ}$
Longshore Current Velocity 21 cm/s
Current Direction North
Wind Velocity 4 mph Azimuth 230 $^{\circ}$

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/1)
1	5	100	
		60	0.211
		30	0.392
		10	0.601
2	5	100	
		60	
		30	0.489
		10	0.665
3	5	100	
		60	
		30	0.350
		10	

PHOTOS TAKEN AT

Station CA-1
Date 2 July, 1977
Time 1235

141

MEAN WAVE PARAMETERS

Breaker Type spill/plunge
Breaker Height (H_b) 115 cm
Depth at Breaking (d) 103 cm
d/H_b 0.899
n 9

MEAN SUSPENDED SEDIMENT

Sample Elev. (cm)	Conc. (gm/l)	n
100	0.090	2
60	0.115	3
30	0.219	9
10	0.819	9

RESULTS - THIS PHOTO SERIES 61501

H_b 115 d 95
Period 13.0 s α_b 0 °
Longshore Current Velocity 0 cm/s
Current Direction ---
Wind Velocity 2 mph Azimuth 230 °

Array #	Dist. from Break. Pt. (m)	Elev. above Bed (cm)	Conc. (gm/l)
1	2	100	
		60	0.086
		30	0.109
		10	0.328
2	3	100	
		60	
		30	0.286
		10	1.106
3	4	100	
		60	
		30	0.111
		10	0.158

PHOTOS TAKEN AT

Station CA-1
Date 2 July, 1977
Time 1122

APPENDIX B - 1. List of Computer Codes for Variables
2. Example SAS76 Program Statements and Job Control Cards
3. Data Printout for Selected Observations and Variables

1. Computer Codes

Field Generated Variables

Code	Definition
OBS	OBSERVATION NUMBER - computer generated
SERIES	NUMBER ASSIGNED - to each wave sampled
OPERATOR	IDENTIFYER - name of sampler operator
STA	STATION IDENTIFICATION
DATE	DATE - month, day, year
TIME	TIME - 24 hour system
WINDVEL	WIND VELOCITY - mph
WINDAZI	WIND AZIMUTH - degrees
WVHT	BREAKER HEIGHT - cm
WVDPTH	BREAKER DEPTH - cm
PER	WAVE PERIOD - seconds
WVTYPE	VISUAL WAVE TYPE - 1=spilling 2=plunging 3=transition 4=non-breaking
LSCUR	LONGSHORE CURRENT VELOCITY - cm/s
LSDIR	LONGSHORE CURRENT DIRECTION - 1=to left 2=to right, viewed from shore
ALPHAB	BREAKER ANGLE - degrees
MOFF	AVERAGE BEACH SLOPE - seaward of breakpt.
STKDIST	DISTANCE FROM BENCHMARK ON LAND - to sample position
CRSTDIS	DISTANCE FROM BREAKPOINT - (+) is landward and (-) is seaward of breakers
BOREHT	HEIGHT OF WAVE BORE - at sampler, cm
BOREDPTH	DEPTH UNDER WAVE BORE - cm
SAMSLOPE	BEACH SLOPE AT SAMPLE POSITION
SAMTIME	SAMPLE TIME - with respect to phase of wave, seconds
SS10	SUSPENDED SEDIMENT CONCENTRATION AT 10 CM ABOVE THE BED - gm/l
SS30	"" "" 30 CM "" ""
SS60	"" "" 60 CM "" ""
SS100	"" "" 100 CM "" ""

Computer Generator Variables

D_OVERHB	RATIO WVDPTH/WVHT - d_b/H_b
BRKER	PARAMETER - $(1-m)^4 d_b/H_b$
BB	GALVIN'S BREAKER PARAMETER - $H_b/(gmT^2)$
XI	BATTJES' SURF PARAMETER - $m/(H_b/L_o)^{\frac{1}{2}}$

B - 2. Example SAS76 Program Statements and Job Control Cards

```
//SS77 JOB (T3100203,5),'KANA',TIME=(,9),MSGLEVEL=(1,1),
// USER=T310020,PASSWORD=XXXX
// EXEC SAS76
XXSAS76  PROC  OPTIONS=,SORT=4,ENTRY=SAS
**************************************************************
***  STATISTICAL ANALYSIS SYSTEM,  VERSION 76.6            ***
***  DOCUMENTATION:  A USER'S GUIDE TO SAS 76              ***
***                        AND                             ***
***                 SAS SUPPLEMENTAL LIBRARY               ***
***                      USER'S GUIDE                      ***
**************************************************************
XXSAS     EXEC  PGM=&ENTRY,PARM='&OPTIONS',REGION=256K
XXLIBRARY  DD  DSN=&&LIBRARY,UNIT=SYSDA,SPACE=(TRK,(20,,20))
XXSTEPLIB DD DSN=ACAD,SAS766.LIBRARY,DISP=SHR,VOL=SER=ACAD00,UNIT=3350
XX          DD DSN=PLIX.PLITRNS,DISP=SHR,UNIT=3350,VOL=SER=SYSLNK
XX          DD DSN=SM1.LINKLIB,DISP=SHR,UNIT=3350,VOL=SER=MVSP02
XX          DD DSN=*.LIBRARY,DISP=(OLD,PASS),UNIT=SYSDA,VOL=REF=*.LIBRARY
XXWORK      DD  UNIT=SYSDA,SPACE=(TRK,(240,80)) TEMPORARY DATA SETS
XXFT11F001 DD  SYSOUT=*,DCB=(BLKSIZE=141,LRECL=137,RECFM=VBA) LOG
XXFT12F001 DD  SYSOUT=*,DCB=(BLKSIZE=141,LRECL=137,RECFM=VBA) PRINT
XXFT13F001 DD  SYSOUT=B PUNCH
XXFT15F001 DD  UNIT=SYSDA,SPACE=(TRK,(10,10)), PARMCARDS
XX             DCB=(RECFM=FB,LRECL=80,BLKSIZE=400,BUFNO=1)
***       SYSTEM SORT DEFINITIONS
XXSORTLIB DD DSN=SM1.SORTLIB,DISP=SHR,UNIT=3350,VOL=SER=SYSLNK
XXSYSOUT   DD  SYSOUT=*,DCB=BUFNO=1
XXSORTWK01 DD  SPACE=(CYL,(&SORT)),UNIT=SYSDA
XXSORTWK02 DD  SPACE=(CYL,(&SORT)),UNIT=(SYSDA,,SEP=(SORTWK01))
XXSORTWK03 DD  SPACE=(CYL,(&SORT)),UNIT=(SYSDA,,SEP=(SORTWK01,
XX             SORTWK02))
//DATAN DD DSN=T310020.SUSPEND,DISP=SHR
//SYSIN DD *
//

DATA SS77;
INFILE DATAN;
INPUT SERIES 1-5 SUBSERIS 6 OPERATOR SERORDER ORIENT SECT STA $16-18 DATE TIME
 TIDE WINDVEL WINDAZI WVHT 41-43 WVDPTH 45-47 PER 49-52 WVTYPE 54 LSCUR 56-58
 LSDIR 60 ALPHAB 62-63 ALPHADIR 65 MOFF 67-70 STKDIST 72-74 CRSTDIS 76-77 BOREHT
 79-80 #2 BOREDPTH 1-2 SAMSLOPE 4-7 SAMTIME 9-10 SS10 12-17 SS30 19-24 SS60 26-
 31 SS100 33-38 SS140 40-45;
D_OVERHB=WVDPTH/WVHT;
LOGSS10=LOG10(SS10);
LOGSS30=LOG10(SS30);
LOGSS60=LOG10(SS60);
LOGSS100=LOG10(SS100);
LGSS10=LOGSS10;
LGSS30=LOGSS30;
LGSS60=LOGSS60;
LGSS100=LOGSS100;
S10=SS10;
S30=SS30;
S60=SS60;
BH=WVHT/(980*MOFF*(PER**2));
BORATIO=BOREDPTH/BOREHT;
MF4=(1-MOFF)**4;
BRKTYPE=D_OVERHB*MF4;
SAMSL4=(1-SAMSLOPE)**4;
BRKER=D_OVERHB*SAMSL4;
XI=MOFF/(6.28319*WVHT/980*(PER**2))**0.5;
IF SERIES=60201 AND SUBSERIS=1 THEN DELETE;
IF SERIES=60202 AND SUBSERIS=J THEN DELETE;
IF CRSTDIS<1 THEN DELETE;
IF CRSTDIS>12.5 THEN DELETE;
IF BRKTYPE>1.4 THEN DELETE;

 PROC SORT; BY D_OVERHB;

DATA SET WORK.SS77 HAS 403 OBSERVATIONS AND 51 VARIABLES. 32 OBS/TRK.
THE PROCEDURE SORT USED 0.36 SECONDS AND 108K.

 PROC MEANS NOPRINT; BY D_OVERHB;
 VAR LGSS10 LGSS30 LGSS60;
 OUTPUT OUT=NEWSS2 MEAN=MLGSS10 MLGSS30 MLGSS60;

 PROC PLOT;
 PLOT MLGSS10 * D_OVERHB MLGSS30*D_OVERHB MLGSS60*D_OVERHB;
 PROC CORR; VAR MLGSS10 WVHT D_OVERHB WVDPTH MOFF PER LSCUR WINDVEL SAMSLOPE;

THE PROCEDURE CORR USED 0.40 SECONDS AND 132K AND PRINTED PAGE 41.

SAS USED 152K MEMORY.

BARR, GOODNIGHT, SALL AND HELWIG
SAS INSTITUTE INC.
P.O. BOX 10066
RALEIGH, N.C. 27605
```

B - 3. Data Printout for Selected Observations and Variables.

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERHB	BREKER	HR	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
1	60101	CA1	61177	1005	55	45	8.2	1.18	1.10	0.052	0.0032	1	6	2	0	0.016	3	0.287	.	0.034
2	60101	CA1	61177	1005	55	45	8.2	1.18	1.10	0.052	0.0032	1	6	2	0	0.016	3	0.309	0.030	0.079
3	60101	CA1	61177	1005	55	55	8.2	1.18	1.10	0.052	0.0032	1	6	2	0	0.016	3	0.097	.	0.015
4	60102	CA1	61177	1030	55	60	8.0	1.09	1.02	0.054	0.0033	1	0	0	0	0.016	2	.	.	0.035
5	60102	CA1	61177	1030	55	60	8.0	1.09	1.02	0.054	0.0033	1	0	0	0	0.016	2	0.274	0.070	0.085
6	60102	CA1	61177	1030	55	50	8.0	1.09	1.02	0.054	0.0033	1	0	0	0	0.016	2	0.046	.	0.033
7	60103	CA1	61177	1045	55	60	8.0	1.09	1.02	0.054	0.0033	1	0	0	0	0.016	2	0.223	0.099	0.045
8	60103	CA1	61177	1045	55	60	8.0	1.09	1.02	0.054	0.0033	1	0	0	0	0.016	2	0.119	.	0.066
9	60103	CA1	61177	1045	55	50	8.0	1.09	1.02	0.054	0.0033	1	0	0	0	0.016	2	0.240	.	0.064
10	60104	CA1	61177	1105	50	50	8.2	1.20	1.12	0.047	0.0034	1	0	0	0	0.016	2	0.055	.	0.042
11	60104	CA1	61177	1105	50	60	8.2	1.20	1.12	0.047	0.0034	1	0	0	0	0.016	1	0.412	0.102	0.049
12	60104	CA1	61177	1105	50	50	8.2	1.20	1.12	0.047	0.0034	1	0	0	0	0.016	0	0.076	.	0.042
13	60105	CA1	61177	1120	65	70	8.2	1.07	1.00	0.061	0.0030	1	0	0	0	0.016	1	0.120	.	0.018
14	60105	CA1	61177	1120	65	70	8.2	1.07	1.00	0.061	0.0030	1	0	0	0	0.016	0	0.021	.	0.015
15	60105	CA1	61177	1120	65	70	8.2	1.07	1.00	0.061	0.0030	1	0	0	0	0.016	0	0.066	.	0.039
16	60106	CA1	61177	1125	60	70	8.0	1.16	1.09	0.059	0.0032	1	0	0	0	0.016	3	0.173	0.094	0.036
17	60106	CA1	61177	1125	60	70	8.0	1.16	1.09	0.059	0.0032	1	0	0	0	0.016	2	0.055	.	0.022
18	60106	CA1	61177	1125	60	70	8.0	1.16	1.09	0.059	0.0032	1	0	0	0	0.016	2	0.280	.	0.032
19	60107	CA1	61177	1150	60	70	8.0	1.16	1.09	0.059	0.0032	1	0	0	0	0.016	2	0.042	.	0.021
20	60107	CA1	61177	1150	60	70	8.0	1.16	1.09	0.059	0.0032	1	0	0	0	0.016	3	0.075	0.056	0.030
21	60107	CA1	61177	1150	60	65	8.0	1.08	1.01	0.059	0.0032	1	0	0	0	0.016	1	0.497	.	0.018
22	60108	CA1	61177	1205	65	75	6.5	1.15	1.08	0.098	0.0038	1	0	0	0	0.016	2	0.146	0.079	0.020
23	60108	CA1	61177	1205	70	75	6.5	1.07	1.00	0.105	0.0036	1	0	0	0	0.016	2	0.452	.	0.046
24	60108	CA1	61177	1205	75	80	6.5	1.06	1.00	0.113	0.0035	1	0	0	0	0.016	3	0.216	.	0.021
25	60109	CA1	61177	1240	70	80	7.0	1.14	1.01	0.048	0.0063	1	0	0	0	0.030	3	0.157	.	0.035
26	60109	CA1	61177	1240	70	80	7.0	1.14	1.01	0.048	0.0063	1	0	0	0	0.030	2	0.077	0.015	0.012
27	60109	CA1	61177	1240	70	80	7.0	1.14	1.01	0.048	0.0063	1	0	0	0	0.030	2	0.604	.	0.021
28	60110	CA1	61177	1300	65	70	7.0	1.07	0.98	0.064	0.0046	1	0	0	0	0.021	-1	0.038	0.030	0.031
29	60110	CA1	61177	1300	65	70	7.0	1.07	0.98	0.064	0.0046	1	0	0	0	0.021	-1	0.033	.	0.041
30	60110	CA1	61177	1300	65	70	7.0	1.07	0.98	0.064	0.0046	1	0	0	0	0.021	0	0.293	.	0.024
31	60111	CA1	61177	1315	70	80	7.0	1.14	1.04	0.069	0.0044	1	0	0	0	0.021	1	0.095	.	0.022
32	60111	CA1	61177	1315	70	80	7.0	1.14	1.04	0.069	0.0044	1	0	0	0	0.021	1	0.328	.	0.023
33	60111	CA1	61177	1315	70	80	7.0	1.14	1.04	0.069	0.0044	1	0	0	0	0.021	1	0.313	0.039	0.026
34	60112	CA1	61177	1340	60	70	7.0	1.16	1.08	0.073	0.0039	1	18	1	0	0.017	3	0.073	0.030	0.019
35	60112	CA1	61177	1340	60	70	7.0	1.16	1.08	0.073	0.0039	1	18	1	0	0.017	1	0.211	.	0.025
36	60112	CA1	61177	1340	60	70	7.0	1.16	1.08	0.073	0.0039	1	18	1	0	0.017	1	0.192	.	0.020
37	60113	CA1	61177	1355	60	70	7.0	1.16	1.08	0.073	0.0039	1	18	1	0	0.017	2	0.208	.	0.062
38	60113	CA1	61177	1355	60	70	7.0	1.16	1.08	0.073	0.0039	1	18	1	0	0.017	2	0.275	.	0.033
39	60113	CA1	61177	1355	60	70	7.0	1.16	1.08	0.073	0.0039	1	18	1	0	0.017	3	0.020	0.049	0.019
40	60201	BU2	61277	1045	80	100	6.2	1.25	1.23	0.265	0.0018	1	17	1	3	0.008	13	0.219	.	0.071
41	60201	BU2	61277	1045	80	100	6.2	1.25	1.02	0.265	0.0018	1	17	1	3	0.008	23	0.446	.	.
42	60202	BU2	61277	1105	80	100	6.0	1.25	1.21	0.283	0.0018	1	17	1	4	0.008	5	0.441	0.223	0.046
43	60202	BU2	61277	1105	80	100	6.0	1.25	1.02	0.283	0.0018	1	17	1	4	0.008	25	0.354	.	0.055
44	60203	BU2	61277	1130	80	95	6.0	1.18	1.14	0.283	0.0018	1	17	1	4	0.008	4	0.092	0.097	0.056
45	60203	BU2	61277	1130	80	95	6.0	1.18	0.97	0.283	0.0018	1	17	1	4	0.008	24	0.121	.	0.049
46	60204	BU2	61277	1155	75	95	6.0	1.13	1.09	0.265	0.0019	1	17	1	4	0.008	1	0.115	0.099	0.059
47	60204	BU2	61277	1155	75	95	6.0	1.13	1.11	0.265	0.0019	1	17	1	4	0.008	15	0.161	.	0.028

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERHB	BREKER	HR	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
48	60204	BU2	61277	1155	25	20	6.0	0.80	0.705	0.088	0.0033	3	17	1	4	0.008	0	1.899	1.558	.
49	60205	BU2	61277	1240	50	40	6.0	0.80	0.657	0.045	0.0091	4	33	1	8	0.031	-9	0.528	0.275	0.097
50	60205	BU2	61277	1240	50	40	6.0	0.80	0.705	0.045	0.0091	4	33	1	8	0.031	-5	1.904	.	0.158
51	60206	BU2	61277	1255	55	70	5.0	1.27	1.122	0.072	0.0104	3	33	1	8	0.031	5	0.220	0.120	0.070
52	60206	BU2	61277	1255	55	70	5.0	1.27	1.122	0.072	0.0104	3	33	1	8	0.031	8	0.177	.	0.073
53	60206	BU2	61277	1255	55	70	5.0	1.27	1.122	0.072	0.0104	3	33	1	8	0.031	10	1.100	0.789	.
54	60207	BU2	61277	1320	75	80	4.3	1.06	0.940	0.133	0.0103	1	33	1	8	0.031	5	0.275	.	.
55	60208	BU2	61277	1340	90	100	4.0	1.11	0.979	0.185	0.0102	1	50	1	8	0.031	0	0.486	0.101	0.043
56	60208	BU2	61277	1340	90	100	4.0	1.11	0.979	0.185	0.0102	1	50	1	8	0.031	5	1.511	.	0.518
57	60208	BU2	61277	1340	90	100	4.0	1.11	1.067	0.185	0.0102	1	50	1	8	0.031	13	0.245	0.190	.
58	60209	BU2	61277	1355	95	100	4.0	1.05	0.928	0.195	0.0099	4	50	1	8	0.031	-4	0.532	.	0.277
59	60210	BU2	61277	1410	80	90	5.5	1.12	1.046	0.149	0.0045	1	67	1	9	0.018	1	0.711	0.309	0.222
60	60210	BU2	61277	1410	80	90	5.5	1.12	1.080	0.149	0.0045	1	67	1	9	0.018	11	0.362	.	0.150
61	60210	BU2	61277	1410	30	30	4.0	1.00	0.926	0.100	0.0108	2	67	1	9	0.019	1	1.100	.	.
62	60301	PI1	61377	1010	90	70	7.0	0.87	0.817	0.097	0.0033	3	15	2	5	0.017	1	1.749	0.438	0.230
63	60301	PI1	61377	1010	80	70	7.0	0.87	0.817	0.097	0.0033	3	15	2	5	0.017	1	0.850	0.283	.
64	60301	PI1	61377	1010	80	70	7.0	0.87	0.817	0.097	0.0033	3	15	2	5	0.017	1	0.841	.	0.210
65	60302	PI1	61377	1015	80	70	8.0	0.87	0.813	0.070	0.0031	1	15	2	5	0.018	4	0.236	0.190	0.167
66	60302	PI1	61377	1015	80	70	8.0	0.87	0.813	0.070	0.0031	1	15	2	5	0.018	4	0.360	.	0.196
67	60303	PI1	61377	1015	75	70	7.0	0.93	0.867	0.086	0.0037	1	15	2	5	0.018	5	0.228	0.165	.
68	60304	PI1	61377	1025	70	60	7.0	0.85	0.797	0.080	0.0038	1	15	2	5	0.018	2	0.099	0.031	.
69	60304	PI1	61377	1025	70	50	7.0	0.85	0.797	0.080	0.0038	1	15	2	5	0.018	2	0.104	.	.
70	60305	PI1	61377	1055	60	55	7.0	0.91	0.852	0.069	0.0041	1	0	0	5	0.018	2	0.285	0.211	0.156
71	60305	PI1	61377	1055	60	55	7.0	0.91	0.852	0.069	0.0041	1	0	0	5	0.018	2	0.131	0.129	.
72	60305	PI1	61377	1055	60	55	7.0	0.91	0.852	0.069	0.0041	1	0	0	5	0.018	2	0.299	.	.
73	60306	PI1	61377	1110	65	55	7.0	0.84	0.790	0.079	0.0037	1	0	0	5	0.017	2	0.336	0.207	0.133
74	60306	PI1	61377	1110	60	55	7.0	0.91	0.855	0.073	0.0039	1	0	0	5	0.017	2	0.356	.	0.049
75	60307	PI1	61377	1125	70	60	7.0	0.85	0.806	0.097	0.0031	1	25	1	5	0.015	3	0.264	0.115	0.073
76	60307	PI1	61377	1125	70	60	7.0	0.85	0.806	0.097	0.0031	1	25	1	5	0.015	3	0.294	0.286	.
77	60307	PI1	61377	1125	70	60	7.0	0.85	0.806	0.097	0.0031	1	25	1	5	0.015	3	0.124	.	0.032
78	60308	PI1	61377	1140	70	60	7.0	0.85	0.846	0.485	0.0006	1	25	1	5	0.003	0	0.091	0.225	0.075
79	60308	PI1	61377	1140	70	60	7.0	0.85	0.846	0.485	0.0006	1	25	1	5	0.003	0	0.296	.	0.138
80	60308	PI1	61377	1140	70	60	7.0	0.85	0.846	0.485	0.0006	1	25	1	5	0.003	0	0.462	0.181	.
81	60309	PI1	61377	1153	80	70	6.0	0.87	0.823	0.151	0.0034	3	37	1	5	0.015	5	0.820	0.476	0.137
82	60309	PI1	61377	1153	80	70	6.0	0.87	0.823	0.151	0.0034	1	37	1	5	0.015	5	0.489	0.372	.
83	60309	PI1	61377	1153	80	70	6.0	0.87	0.823	0.151	0.0034	1	37	1	5	0.015	5	0.141	.	0.079
84	60310	PI1	61377	1210	70	60	6.5	0.85	0.806	0.112	0.0034	1	37	1	5	0.015	5	0.470	0.059	0.084
85	60310	PI1	61377	1210	70	60	6.5	0.85	0.806	0.112	0.0034	1	37	1	5	0.015	5	0.856	0.299	.
86	60311	PI1	61377	1252	75	55	7.0	0.73	0.684	0.091	0.0035	3	14	1	5	0.017	5	0.451	0.087	0.028
87	60311	PI1	61377	1252	75	55	7.0	0.73	0.684	0.091	0.0035	3	14	1	5	0.017	5	0.266	0.144	.
88	60311	PI1	61377	1252	75	55	7.0	0.73	0.684	0.091	0.0035	3	14	1	5	0.017	5	0.278	.	0.028
89	60312	PI1	61377	1310	70	55	6.5	0.78	0.730	0.093	0.0041	3	14	1	5	0.018	1	0.609	.	0.098
90	60312	PI1	61377	1310	70	55	6.5	0.78	0.730	0.093	0.0041	3	14	1	5	0.018	1	0.566	0.396	.
91	60313	PI1	61377	1325	90	75	5.0	0.83	0.774	0.204	0.0047	3	0	0	5	0.018	2	0.610	1.073	0.427
92	60313	PI1	61377	1325	90	75	5.0	0.83	0.774	0.204	0.0047	3	0	0	5	0.018	2	0.137	.	0.322
93	60313	PI1	61377	1325	90	75	5.0	0.83	0.774	0.204	0.0047	3	0	0	5	0.018	2	0.782	0.357	.
94	60314	PI1	61377	1336	90	75	5.0	0.83	0.774	0.204	0.0047	3	17	2	5	0.018	5	1.003	0.479	0.304

Data Printout for Selected Observations and Variables

OBS	SERIES	STA	DATE	TIME	WHT	WVDPTH	PER	DOVERHB	BRKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MUOFF	CRSTDIS	SS10	SS30	SS60
95	60314	PI1	61377	1336	90	75	5.0	0.83	0.774	0.204	0.0047	3	17	2	5	0.018	4	0.867	.	.
96	60314	PI1	61377	1336	90	75	5.0	0.83	0.774	0.204	0.0047	3	17	2	5	0.018	4	0.390	.	0.299
97	60401	CA1	61477	1112	80	85	7.0	1.06	0.940	0.055	0.0059	1	36	2	5	0.030	3	0.798	0.244	0.189
98	60401	CA1	61477	1112	80	85	7.0	1.06	0.492	0.055	0.0059	1	36	2	5	0.030	13	1.612	.	.
99	60402	CA1	61477	1117	90	90	7.0	1.00	0.985	0.062	0.0056	1	36	2	5	0.030	7	0.144	0.100	0.078
100	60404	CA1	61477	1150	75	75	6.0	1.00	0.885	0.070	0.0072	1	36	2	5	0.030	3	0.437	0.294	0.156
101	60404	CA1	61477	1150	75	75	6.0	1.00	0.918	0.070	0.0072	1	36	2	5	0.030	13	0.743	0.196	.
102	60405	CA1	61477	1200	90	95	7.0	1.05	0.934	0.062	0.0056	1	36	2	5	0.030	7	0.046	0.049	0.032
103	60405	CA1	61477	1200	90	95	7.0	1.05	0.969	0.062	0.0056	1	36	2	5	0.030	17	0.176	0.242	.
104	60406	CA1	61477	1215	95	100	7.0	1.05	1.035	0.494	0.0007	1	36	2	5	0.004	2	0.447	0.291	0.878
105	60406	CA1	61477	1215	95	100	7.0	1.05	0.931	0.494	0.0007	1	36	2	5	0.004	7	0.637	0.283	.
106	60407	CA1	61477	1230	100	100	7.0	1.00	0.937	0.130	0.0028	3	36	2	3	0.016	2	1.925	1.093	0.152
107	60407	CA1	61477	1230	100	100	7.0	1.00	0.885	0.130	0.0028	3	36	2	3	0.016	8	2.357	0.636	.
108	60408	CA1	61477	1312	95	90	7.0	0.94	0.888	0.123	0.0029	3	36	2	3	0.016	2	0.235	0.278	0.247
109	60408	CA1	61477	1312	95	90	7.0	0.94	0.938	0.123	0.0029	3	36	2	3	0.016	7	0.429	0.192	.
110	60409	CA1	61477	1324	90	90	7.0	1.00	0.984	0.468	0.0007	3	36	2	3	0.004	2	0.064	0.050	0.054
111	60409	CA1	61477	1324	90	90	7.0	1.00	0.995	0.468	0.0007	3	36	2	3	0.004	7	0.244	0.244	.
112	60410	CA1	61477	1340	90	90	7.0	1.00	0.984	0.468	0.0007	3	36	2	3	0.004	1	0.688	0.601	0.062
113	60410	CA1	61477	1340	90	90	7.0	1.00	0.885	0.468	0.0007	3	36	2	3	0.004	6	0.866	0.735	.
114	60412	CA1	61477	1405	90	85	7.0	0.94	0.929	0.468	0.0007	3	33	2	3	0.004	1	0.207	0.041	0.064
115	60412	CA1	61477	1405	90	85	7.0	0.94	0.836	0.468	0.0007	3	33	2	3	0.004	6	0.376	0.208	.
116	60413	CA1	61477	1418	90	90	6.8	1.00	0.945	0.066	0.0058	3	18	2	2	0.030	2	0.151	0.169	0.117
117	60413	CA1	61477	1418	90	90	6.8	1.00	0.885	0.066	0.0058	3	18	2	2	0.030	7	0.589	0.217	.
118	60501	BU2	61577	1105	70	50	11.5	0.71	0.664	0.030	0.0023	2	10	2	2	0.018	2	0.196	0.090	.
119	60501	BU2	61577	1105	70	50	11.5	0.71	0.664	0.030	0.0023	2	10	2	2	0.018	2	0.373	0.301	.
120	60502	BU2	61577	1120	70	50	9.0	0.71	0.664	0.048	0.0029	2	10	2	2	0.018	3	1.463	1.209	.
121	60502	BU2	61577	1120	70	50	9.0	0.71	0.664	0.048	0.0029	3	10	2	2	0.018	5	1.266	0.801	.
122	60503	BU2	61577	1131	70	50	9.0	0.71	0.664	0.048	0.0029	2	10	2	2	0.018	9	2.694	1.810	.
123	60503	BU2	61577	1131	70	50	9.0	0.71	0.864	0.048	0.0029	2	10	2	2	0.018	9	1.766	.	.
124	60503	BU2	61577	1131	70	50	9.0	0.71	0.664	0.048	0.0029	2	10	2	2	0.018	9	1.453	1.049	.
125	60505	BU2	61577	1205	40	25	7.0	0.62	0.615	0.208	0.0011	2	10	2	2	0.004	2	0.599	0.541	.
126	60505	BU2	61577	1205	40	25	7.0	0.62	0.615	0.208	0.0011	2	10	2	2	0.004	2	1.090	0.650	.
127	60506	BU2	61577	1215	35	30	8.5	0.85	0.843	0.123	0.0009	2	10	2	2	0.004	2	2.614	1.945	.
128	60506	BU2	61577	1215	35	30	8.5	0.85	0.843	0.123	0.0009	2	10	2	2	0.004	2	1.753	0.895	.
129	60507	BU2	61577	1233	30	25	8.0	0.83	0.820	0.119	0.0011	2	10	2	2	0.004	1	2.681	2.158	.
130	60507	BU2	61577	1233	30	25	8.0	0.83	0.820	0.119	0.0011	2	10	2	2	0.004	1	2.642	1.513	.
131	60508	BU2	61577	1320	80	80	8.0	1.00	0.984	0.318	0.0006	1	0	0	6	0.004	5	1.163	0.208	0.114
132	60508	BU2	61577	1320	80	80	8.0	1.00	0.821	0.318	0.0006	1	0	0	6	0.004	10	0.148	0.060	.
133	60508	BU2	61577	1320	80	80	8.0	1.00	0.881	0.318	0.0006	1	0	0	6	0.004	15	0.210	0.090	.
134	60509	BU2	61577	1340	90	85	8.0	0.94	0.929	0.358	0.0006	1	0	0	6	0.004	4	0.447	0.088	0.067
135	60509	BU2	61577	1340	90	85	8.0	0.94	0.775	0.358	0.0006	1	0	0	6	0.004	9	0.287	0.030	.
136	60509	BU2	61577	1340	90	85	8.0	0.94	0.775	0.358	0.0006	1	0	0	6	0.004	14	0.695	0.182	.
137	60510	BU2	61577	1355	80	85	8.0	1.06	1.045	0.318	0.0006	1	10	2	6	0.004	1	0.616	0.126	0.023
138	60510	BU2	61577	1355	80	85	8.0	1.06	0.872	0.318	0.0006	1	10	2	6	0.004	9	0.250	.	.
139	60510	BU2	61577	1355	80	85	8.0	1.06	0.936	0.318	0.0006	1	10	2	6	0.004	15	0.250	0.125	.
140	60511	BU2	61577	1410	75	90	8.0	1.20	0.985	0.298	0.0007	1	10	2	6	0.004	4	0.052	0.058	.
141	60511	BU2	61577	1410	75	90	8.0	1.20	0.985	0.298	0.0007	1	10	2	6	0.004	7	0.114	0.023	.

OBS	SERIES	STA	DATE	TIME	WHT	WVDPTH	PER	DOVERHB	BRKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MUOFF	CRSTDIS	SS10	SS30	SS60
142	60511	BU2	61577	1410	75	90	8.0	1.20	1.180	0.298	0.0007	1	10	2	6	0.004	16	0.637	0.163	.
143	60512	BU2	61577	1425	55	60	8.0	1.09	1.073	0.219	0.0008	1	10	2	4	0.004	7	0.696	0.284	.
144	60513	BU2	61577	1435	35	60	9.0	1.71	1.511	0.014	0.0072	3	10	2	3	0.031	.	0.305	.	.
145	60513	BU2	61577	1435	35	60	9.0	1.71	1.667	0.014	0.0072	3	10	2	3	0.031	.	0.882	0.705	.
146	60513	BU2	61577	1435	35	60	9.0	1.71	1.594	0.014	0.0072	3	10	2	3	0.031	.	0.580	.	.
147	60601	CA1	61677	1103	65	70	7.5	1.07	1.059	0.294	0.0008	1	36	2	8	0.004	3	0.141	0.845	0.024
148	60601	CA1	61677	1103	65	70	7.5	1.07	0.953	0.294	0.0008	1	36	2	8	0.004	6	0.193	0.048	.
149	60601	CA1	61677	1103	65	70	7.5	1.07	0.953	0.294	0.0008	1	36	2	8	0.004	9	1.508	0.209	.
150	60602	CA1	61677	1118	50	55	7.5	1.30	1.150	0.226	0.0009	1	36	2	8	0.004	2	0.368	0.127	.
151	60602	CA1	61677	1118	50	55	7.5	1.30	1.150	0.226	0.0009	1	36	2	8	0.004	5	0.124	0.161	.
152	60603	CA1	61677	1130	65	75	7.5	1.15	1.135	0.294	0.0008	1	36	2	9	0.004	3	0.116	0.855	0.093
153	60603	CA1	61677	1130	65	75	7.5	1.15	1.135	0.294	0.0008	1	36	2	9	0.004	5	0.343	0.219	.
154	60603	CA1	61677	1130	65	75	7.5	1.15	1.135	0.294	0.0008	1	36	2	9	0.004	7	0.161	0.275	.
155	60604	CA1	61677	1145	50	55	7.5	1.10	1.031	0.056	0.0037	1	36	2	9	0.016	1	0.068	0.056	0.049
156	60604	CA1	61677	1145	50	55	7.5	1.10	1.082	0.056	0.0037	1	36	2	9	0.016	3	0.184	0.181	.
157	60604	CA1	61677	1145	50	55	7.5	1.10	1.082	0.056	0.0037	1	36	2	9	0.016	5	0.293	0.213	.
158	60605	CA1	61677	1200	70	60	7.5	0.85	0.803	0.079	0.0031	3	36	2	9	0.016	1	0.445	0.260	0.211
159	60605	CA1	61677	1200	70	60	7.5	0.85	0.803	0.079	0.0031	3	36	2	9	0.016	3	0.153	.	.
160	60605	CA1	61677	1200	70	60	7.5	0.85	0.843	0.079	0.0031	3	36	2	9	0.016	6	0.278	0.126	.
161	60607	CA1	61677	1300	45	55	7.5	1.22	1.136	0.045	0.0044	1	48	2	9	0.018	4	0.048	0.837	0.030
162	60607	CA1	61677	1300	45	55	7.5	1.22	1.136	0.045	0.0044	1	48	2	9	0.018	7	0.278	0.113	.
163	60607	CA1	61677	1300	25	25	7.5	1.00	0.937	0.028	0.0053	3	48	2	9	0.016	1	1.948	1.086	.
164	60608	CA1	61677	1318	35	65	7.0	1.85	1.727	0.040	0.0054	1	48	2	9	0.018	2	0.060	0.059	0.053
165	60608	CA1	61677	1318	35	65	7.0	1.85	1.727	0.040	0.0054	1	48	2	9	0.018	7	0.071	0.066	.
166	60608	CA1	61677	1318	35	65	7.0	1.85	1.741	0.040	0.0054	1	48	2	9	0.018	12	0.678	0.076	.
167	60701	PI1	61877	907	50	35	8.0	0.70	0.650	0.027	0.0064	4	0	0	0	0.029	-9	0.178	0.120	0.061
168	60701	PI1	61877	907	50	35	8.0	0.70	0.604	0.027	0.0064	4	0	0	0	0.029	-4	0.077	0.076	.
169	60701	PI1	61877	907	50	35	8.0	0.70	0.622	0.027	0.0064	2	0	0	0	0.029	1	3.678	0.110	.
170	60702	PI1	61877	919	65	75	7.0	1.15	1.072	0.075	0.0039	1	0	0	0	0.018	6	0.080	0.037	0.020
171	60702	PI1	61877	919	40	35	7.0	0.87	0.777	0.028	0.0081	3	0	0	0	0.029	2	0.423	0.243	.
172	60703	PI1	61877	937	50	35	7.0	0.70	0.622	0.035	0.0073	3	0	0	0	0.029	0	0.189	0.047	.
173	60703	PI1	61877	937	50	35	7.0	0.70	0.622	0.035	0.0073	3	0	0	0	0.029	2	1.172	0.334	.
174	60704	PI1	61877	956	20	20	7.0	1.00	0.941	0.027	0.0059	1	0	0	0	0.015	2	0.292	.	.
175	60705	PI1	61877	1011	40	45	6.0	1.12	1.048	0.031	0.0118	4	0	0	0	0.036	-9	0.526	0.145	0.050
176	60705	PI1	61877	1011	40	45	6.0	1.12	0.971	0.031	0.0118	4	0	0	0	0.036	-2	0.391	0.053	.
177	60705	PI1	61877	1011	40	45	6.0	1.12	1.000	0.031	0.0118	3	0	0	0	0.036	6	0.541	.	.
178	60706	PI1	61877	1030	45	65	6.0	1.44	1.432	0.037	0.0006	1	0	0	0	0.002	2	0.420	0.150	0.051
179	60706	PI1	61877	1030	45	65	6.0	1.44	1.247	0.037	0.0006	1	0	0	0	0.002	12	0.370	0.200	.
180	60707	PI1	61877	1134	40	50	14.0	1.25	1.141	0.014	0.0019	1	0	0	0	0.014	2	0.319	0.226	0.026
181	60707	PI1	61877	1134	40	50	14.0	1.25	1.240	0.014	0.0019	1	0	0	0	0.014	13	0.244	0.123	.
182	60707	PI1	61877	1134	20	20	14.0	1.00	0.929	0.005	0.0035	4	0	0	0	0.018	-2	0.602	0.026	.
183	60709	PI1	61877	1240	35	45	10.0	1.28	1.205	0.022	0.0033	1	0	0	0	0.016	2	0.332	0.067	.
184	60709	PI1	61877	1240	35	45	10.0	1.28	1.215	0.022	0.0033	1	0	0	0	0.016	10	0.122	.	.
185	60709	PI1	61877	1240	35	45	10.0	1.28	1.225	0.022	0.0033	1	0	0	0	0.016	17	1.263	.	.
186	60711	PI1	61877	1240	35	50	6.0	1.42	1.361	0.082	0.0042	1	0	0	0	0.012	0	0.093	0.036	.
187	60711	PI1	61877	1240	35	50	6.0	1.42	1.411	0.082	0.0042	1	0	0	0	0.012	10	0.056	.	.
188	60711	PI1	61877	1240	35	50	6.0	1.42	1.339	0.082	0.0042	1	0	0	0	0.012	20	0.799	.	.

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERHB	HBKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOF	CRSTDIS	SS10	SS30	SS60
189	60712	PI1	61877	1315	35	40	9.0	1.14	1.088	0.0367	0.0028	1	0	0	0	0.012	1	0.077	0.052	.
190	60712	PI1	61877	1315	35	40	9.0	1.14	1.071	0.0367	0.0028	1	0	0	0	0.012	6	1.154	.	.
191	60712	PI1	61877	1315	35	40	9.0	1.14	1.129	0.0367	0.0028	1	0	0	0	0.012	11	0.566	.	.
192	60713	PI1	61877	1324	30	45	7.0	1.50	1.429	0.0347	0.0058	1	0	0	0	0.018	1	0.139	0.071	.
193	60713	PI1	61877	1324	30	45	7.0	1.50	1.429	0.0347	0.0058	1	0	0	0	0.018	4	0.063	.	.
194	60713	PI1	61877	1324	30	45	7.0	1.50	1.406	0.0347	0.0058	1	0	0	0	0.018	7	0.056	.	.
195	60714	PI1	61877	1334	45	50	9.0	1.11	1.058	0.0472	0.0024	1	0	0	0	0.012	6	0.246	.	.
196	60714	PI1	61977	1334	45	50	9.0	1.11	1.041	0.0472	0.0024	1	0	0	0	0.012	9	0.064	.	.
197	60715	PI1	61877	1359	40	50	8.0	1.25	1.167	0.0425	0.0037	1	0	0	0	0.015	7	0.154	0.035	.
198	60801	BU2	61977	1108	60	75	5.5	1.25	1.176	0.1349	0.0043	1	31	1	8	0.015	2	0.139	0.143	0.096
199	60801	BU2	61977	1108	60	75	5.5	1.25	1.157	0.1349	0.0043	1	31	1	8	0.015	8	0.129	0.123	.
200	60802	BU2	61977	1123	50	60	5.0	1.20	1.129	0.1360	0.0052	4	31	1	8	0.015	-4	0.846	0.073	0.066
201	60802	BU2	61977	1123	50	60	5.0	1.20	1.111	0.1360	0.0052	4	31	1	8	0.015	-2	0.656	0.109	.
202	60802	BU2	61977	1123	50	60	5.0	1.20	1.111	0.1360	0.0052	1	31	1	8	0.015	0	0.090	0.077	.
203	60804	BU2	61977	1135	55	65	5.0	1.18	1.112	0.1496	0.0050	1	31	1	8	0.015	1	0.105	0.084	0.079
204	60804	BU2	61977	1150	55	65	5.0	1.18	1.112	0.1496	0.0050	1	31	1	8	0.015	4	0.186	0.145	.
205	60804	BU2	61977	1150	55	65	5.0	1.18	1.094	0.1496	0.0050	1	31	1	8	0.015	6	0.245	0.135	.
206	60805	BU2	61977	1205	45	55	5.0	1.22	1.150	0.1274	0.0055	1	31	1	8	0.015	1	0.300	.	.
207	60806	BU2	61977	1221	70	65	5.0	0.92	0.863	0.1587	0.0053	2	31	1	8	0.018	1	0.084	0.223	0.064
208	60806	BU2	61977	1221	70	65	5.0	0.92	0.891	0.1587	0.0053	2	31	1	8	0.018	4	0.123	0.098	.
209	60806	BU2	61977	1221	70	65	5.0	0.92	0.891	0.1587	0.0053	2	31	1	8	0.018	7	0.147	0.095	.
210	60807	BU2	61977	1305	80	65	5.5	0.81	0.716	0.0870	0.0078	2	45	1	8	0.031	1	0.217	0.641	0.511
211	60807	BU2	61977	1305	80	65	5.5	0.81	0.799	0.0870	0.0078	2	45	1	8	0.031	5	0.148	0.125	.
212	60807	BU2	61977	1305	80	65	5.5	0.81	0.755	0.0870	0.0078	2	45	1	8	0.031	8	0.467	0.243	.
213	60808	BU2	61977	1324	45	50	4.0	1.11	0.979	0.0925	0.0144	1	67	1	10	0.031	1	0.322	0.211	0.147
214	60808	BU2	61977	1324	45	50	4.0	1.11	1.093	0.0925	0.0144	1	67	1	10	0.031	4	0.296	0.134	.
215	60808	BU2	61977	1324	45	50	4.0	1.11	1.093	0.0925	0.0144	1	67	1	10	0.031	7	0.225	0.123	.
216	60811	BU2	61977	1350	55	50	4.0	0.90	0.801	0.1131	0.0130	1	67	1	10	0.031	1	0.560	0.426	0.206
217	60811	BU2	61977	1350	55	50	4.0	0.90	0.801	0.1131	0.0130	1	67	1	10	0.031	4	0.501	0.213	.
218	60811	BU2	61977	1350	55	50	4.0	0.90	0.894	0.1131	0.0130	1	67	1	10	0.031	7	0.481	0.272	.
219	60901	CA1	62077	1012	95	100	6.5	1.05	0.982	0.1349	0.0033	1	45	1	8	0.017	0	0.082	0.043	0.033
220	60901	CA1	62077	1012	95	100	6.5	1.05	0.982	0.1349	0.0033	1	45	1	8	0.017	5	0.387	0.160	.
221	60902	CA1	62077	1023	120	120	6.5	1.00	0.933	0.1704	0.0029	1	45	1	8	0.017	2	0.069	0.029	0.029
222	60902	CA1	62077	1023	120	120	6.5	1.00	0.933	0.1704	0.0029	1	45	1	8	0.017	7	0.119	0.072	.
223	60902	CA1	62077	1023	120	120	6.5	1.00	0.933	0.1704	0.0029	1	45	1	8	0.017	12	0.225	0.181	.
224	60903	CA1	62077	1035	110	115	7.0	1.04	0.976	0.1347	0.0028	1	45	1	4	0.017	2	0.089	0.075	0.055
225	60903	CA1	62077	1035	110	115	7.0	1.04	0.976	0.1347	0.0028	1	45	1	4	0.017	9	0.135	0.147	.
226	60903	CA1	62077	1035	110	115	7.0	1.04	0.976	0.1347	0.0028	1	45	1	4	0.017	14	0.172	0.165	.
227	60904	CA1	62077	1055	110	110	5.0	1.00	0.933	0.1834	0.0033	1	25	1	4	0.017	4	0.175	0.113	0.092
228	60904	CA1	62077	1055	110	110	6.0	1.00	0.933	0.1834	0.0033	1	25	1	4	0.017	9	0.611	0.167	.
229	60904	CA1	62077	1055	110	110	6.0	1.00	0.933	0.1834	0.0033	1	25	1	4	0.017	14	0.238	0.099	.
230	60905	CA1	62077	1108	35	35	6.0	1.00	0.926	0.0522	0.0066	3	25	1	4	0.019	5	0.221	0.065	.
231	60905	CA1	62077	1108	35	35	6.0	1.00	0.929	0.0522	0.0066	3	25	1	4	0.019	10	0.337	0.156	.
232	60905	CA1	62077	1108	35	35	6.0	1.00	0.929	0.0522	0.0066	3	25	1	4	0.019	15	0.269	0.119	.
233	60906	CA1	62077	1120	65	55	5.0	0.84	0.761	0.1020	0.0080	3	25	1	4	0.026	1	0.252	0.161	0.099
234	60906	CA1	62077	1120	65	55	5.0	0.84	0.749	0.1020	0.0080	3	25	1	4	0.026	6	0.398	0.255	.
235	60906	CA1	62077	1120	65	55	5.0	0.84	0.783	0.1020	0.0080	3	25	1	4	0.026	11	0.377	0.243	.

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERHB	HBKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOF	CRSTDIS	SS10	SS30	SS60
236	60907	CA1	62077	1130	120	120	5.0	1.00	0.933	0.2881	0.0038	3	25	1	4	0.017	2	0.154	0.137	0.144
237	60907	CA1	62077	1130	120	120	5.0	1.00	0.933	0.2881	0.0038	3	25	1	4	0.017	9	0.294	0.272	.
238	60907	CA1	62077	1130	120	120	5.0	1.00	0.933	0.2881	0.0038	3	25	1	4	0.017	14	0.304	0.277	.
239	60908	CA1	62077	1145	130	130	7.0	1.00	0.933	0.1592	0.0026	1	25	1	7	0.017	3	0.054	0.044	.
240	60908	CA1	62077	1145	130	130	7.0	1.00	0.933	0.1592	0.0026	1	25	1	7	0.017	8	0.060	0.065	.
241	60908	CA1	62077	1145	130	130	7.0	1.00	0.929	0.1592	0.0026	1	25	1	7	0.017	42	.	0.168	.
242	60909	CA1	62077	1158	95	100	8.0	1.05	0.982	0.0890	0.0027	1	48	1	8	0.017	0	0.050	0.049	0.056
243	60909	CA1	62077	1158	95	100	8.0	1.05	0.982	0.0890	0.0027	1	48	1	8	0.017	5	0.273	0.128	.
244	60909	CA1	62077	1158	95	100	8.0	1.05	0.982	0.0890	0.0027	1	48	1	8	0.017	10	0.110	0.126	.
245	61001	PI1	62177	1208	65	55	7.5	0.84	0.839	0.5895	0.0004	1	48	1	0	0.002	2	0.147	0.106	0.052
246	61002	PI1	62177	1221	55	50	7.5	0.90	0.901	0.4988	0.0004	3	48	1	0	0.002	1	0.812	0.306	0.107
247	61002	PI1	62177	1221	35	20	6.0	0.57	0.537	0.0661	0.0052	2	48	1	0	0.015	1	1.948	.	.
248	61003	PI1	62177	1231	65	60	7.0	0.92	0.915	0.6768	0.0004	1	10	2	0	0.002	2	1.049	0.619	0.123
249	61003	PI1	62177	1231	35	20	5.0	0.57	0.537	0.0952	0.0063	2	20	1	0	0.015	1	6.717	.	.
250	61004	PI1	62177	1320	25	15	5.0	0.60	0.531	0.0351	0.0144	2	20	1	0	0.029	1	2.696	.	.
251	61005	PI1	62177	1330	65	65	6.0	1.00	0.992	0.9212	0.0005	1	0	0	0	0.002	4	0.947	0.362	0.204
252	61006	PI1	62177	1340	65	60	6.0	0.92	0.879	0.1535	0.0030	3	0	0	0	0.012	2	0.662	0.366	0.177
253	61006	PI1	62177	1340	65	60	6.0	0.92	0.879	0.1535	0.0030	3	0	0	0	0.012	2	0.992	0.328	.
254	61007	PI1	62177	1353	50	55	6.0	1.10	1.048	0.1181	0.0035	1	0	0	0	0.012	1	0.132	0.137	0.085
255	61007	PI1	62177	1353	50	55	6.0	1.10	1.048	0.1181	0.0035	1	0	0	0	0.012	1	1.417	0.073	.
256	61008	PI1	62177	1405	55	45	6.0	0.81	0.779	0.1299	0.0033	3	0	0	0	0.012	2	0.109	0.098	.
257	61008	PI1	62177	1405	55	45	6.0	0.81	0.779	0.1299	0.0033	3	0	0	0	0.012	2	0.671	0.173	.
258	61009	PI1	62177	1413	50	50	6.0	1.00	0.952	0.1181	0.0035	3	0	0	0	0.012	3	0.387	0.251	.
259	61009	PI1	62177	1413	50	50	6.0	1.00	0.952	0.1181	0.0035	3	0	0	0	0.012	3	0.306	0.431	.
260	61101	BU2	62877	1050	90	80	9.9	0.88	0.767	0.0260	0.0047	4	0	0	0	0.036	-3	0.635	0.691	0.116
261	61101	BU2	62877	1050	90	80	9.9	0.88	0.767	0.0260	0.0047	2	0	0	0	0.036	2	0.208	0.080	.
262	61101	BU2	62877	1050	90	80	9.9	0.88	0.826	0.0260	0.0047	2	0	0	0	0.036	7	2.533	0.233	.
263	61102	BU2	62877	1102	80	60	9.0	0.75	0.697	0.0559	0.0027	2	0	0	0	0.018	0	0.433	0.154	0.071
264	61102	BU2	62877	1102	80	60	9.0	0.75	0.666	0.0559	0.0027	2	0	0	0	0.018	5	1.954	.	.
265	61102	BU2	62977	1102	80	60	9.0	0.75	0.726	0.0559	0.0027	2	0	0	0	0.018	10	1.342	0.522	.
266	61103	BU2	62877	1112	65	50	9.0	0.76	0.744	0.1023	0.0013	2	0	0	0	0.008	2	0.409	0.261	.
267	61103	BU2	62877	1112	65	50	9.0	0.76	0.741	0.1023	0.0013	2	0	0	0	0.008	7	0.432	0.270	.
268	61104	BU2	62877	1121	50	50	9.0	1.00	0.960	0.0629	0.0019	2	0	0	0	0.010	10	0.135	0.047	.
269	61104	BU2	62877	1121	20	20	9.0	1.00	0.960	0.0251	0.0031	4	0	0	0	0.010	-8	0.595	0.110	.
270	61104	BU2	62877	1121	20	20	9.0	1.00	0.885	0.0251	0.0031	4	0	0	0	0.010	-3	1.234	0.609	.
271	61105	BU2	62877	1135	25	20	5.0	0.80	0.696	0.0340	0.0149	2	0	0	0	0.030	1	1.558	.	.
272	61105	BU2	62877	1135	25	20	5.0	0.80	0.896	0.0300	0.0169	2	0	0	0	0.034	6	1.094	.	.
273	61106	BU2	62877	1145	.	.	4.0	.	.	.	.	3	0	0	0	0.034	.	0.981	0.575	.
274	61106	BU2	62877	1145	.	.	4.0	.	.	.	.	3	0	0	0	0.034	.	4.197	.	.
275	61106	BU2	62877	1145	.	.	4.0	.	.	.	.	3	0	0	0	0.034	.	7.071	.	.
276	61107	BU2	62877	1155	25	25	8.0	1.00	0.870	0.0117	0.0106	4	0	0	0	0.034	-3	1.220	0.166	.
277	61107	BU2	62877	1155	25	25	8.0	1.00	0.870	0.0117	0.0106	4	0	0	0	0.034	0	0.429	.	.
278	61108	BU2	62877	1207	25	20	6.0	0.80	0.696	0.0208	0.0141	2	0	0	0	0.034	0	1.469	0.543	.
279	61108	BU2	62877	1207	25	20	6.0	0.80	0.696	0.0208	0.0141	2	0	0	0	0.034	3	2.592	.	.
280	61109	BU2	62877	1320	90	80	8.0	0.88	0.860	0.1793	0.0013	1	0	0	0	0.008	4	0.272	0.036	0.040
281	61109	BU2	62877	1320	90	80	8.0	0.84	0.860	0.1793	0.0013	1	0	0	0	0.008	4	0.081	0.123	.
282	61110	BU2	62877	1330	80	90	8.0	1.12	1.085	0.1417	0.0015	1	0	0	0	0.009	2	0.169	0.125	0.062

OBS	SERIES	STA	DATE	TIME	WHT	WVDPTH	PER	DOVERHB	BREKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
283	61110	BU2	62877	1330	80	90	8.0	1.12	1.085	0.1417	0.0015	1	0	0	0	0.009	2	0.547	0.149	.
284	61110	BU2	62877	1330	80	90	8.0	1.12	1.085	0.1417	0.0015	1	0	0	0	0.009	2	0.142	0.141	.
285	61111	BU2	62877	1345	80	85	7.0	1.06	1.024	0.1851	0.0017	1	3	1	0	0.009	3	0.498	0.113	0.061
286	61111	BU2	62877	1345	80	85	7.0	1.06	1.024	0.1851	0.0017	1	3	1	0	0.009	3	0.527	0.141	.
287	61111	BU2	62877	1345	80	85	7.0	1.06	1.024	0.1851	0.0017	1	3	1	0	0.009	3	0.441	0.147	.
288	61112	BU2	62877	1400	85	95	7.0	1.11	0.973	0.0520	0.0065	1	13	1	0	0.034	6	0.121	0.079	0.070
289	61112	BU2	62877	1400	85	95	7.0	1.11	0.973	0.0520	0.0065	4	13	1	0	0.034	-6	1.378	0.186	.
290	61113	BU2	62877	1407	60	60	7.0	1.00	0.870	0.0367	0.0078	3	13	1	3	0.034	2	1.533	0.426	.
291	61114	BU2	62877	1412	75	55	7.0	0.86	0.773	0.0557	0.0057	3	20	1	3	0.028	2	1.055	0.448	0.194
292	61114	BU2	62877	1412	70	65	7.0	0.92	0.828	0.0520	0.0059	1	20	1	3	0.028	1	0.215	0.177	.
293	61115	BU2	62877	1423	70	60	8.4	0.85	0.765	0.0361	0.0049	3	33	1	3	0.028	3	1.134	0.266	0.455
294	61115	BU2	62877	1423	70	60	[illegible].4	0.85	0.765	0.0361	0.0049	3	33	1	3	0.028	3	0.496	0.365	.
295	61115	BU2	62877	1423	65	60	[illegible].4	0.92	0.823	0.0335	0.0051	3	33	1	3	0.028	2	0.951	0.[illegible]43	.
296	61203	CA1	62977	958	75	50	8.0	0.80	0.768	0.1195	0.0018	2	40	1	10	0.010	4	0.812	0.355	.
297	61203	CA1	62977	958	75	50	8.0	0.80	0.787	0.1195	0.0018	2	40	1	10	0.010	8	0.668	0.594	.
298	61204	CA1	62977	1015	95	55	9.0	0.68	0.657	0.1514	0.0016	2	40	1	10	[illegible]	1	3.33[illegible]	2.802	0.170
299	61204	CA1	62977	1015	95	65	8.0	0.68	0.657	0.1514	0.0016	2	40	1	10	0.010	5	[illegible]	0.113	.
300	61204	CA1	62977	1015	95	65	8.0	0.68	0.673	0.1514	0.0016	2	40	1	10	0.010	8	0.873	0.502	.
301	61205	CA1	62977	1030	85	60	8.0	0.70	0.637	0.0677	0.0033	2	40	1	10	0.020	3	1.138	0.274	.
302	61205	CA1	62977	1030	85	60	8.0	0.70	0.678	0.0677	0.0033	2	40	1	10	0.020	10	3.323	1.084	.
303	61206	CA1	62977	1042	80	55	8.0	0.68	0.621	0.0510	0.0043	2	40	1	10	0.025	0	0.187	0.509	0.113
304	61206	CA1	62977	1042	80	55	8.0	0.68	0.621	0.0510	0.0043	2	40	1	10	0.025	4	1.067	0.928	.
305	61206	CA1	62977	1042	80	55	8.0	0.68	0.640	0.0510	0.0043	2	40	1	10	0.025	8	1.599	1.472	.
306	61207	CA1	62977	1100	85	60	8.0	0.70	0.651	0.0677	0.0033	2	40	1	10	0.020	1	2.610	0.374	0.141
307	61207	CA1	62977	1100	85	60	8.0	0.70	0.637	0.0677	0.0033	2	40	1	10	0.020	4	6.255	1.172	.
308	61207	CA1	62977	1100	85	60	8.0	0.70	0.637	0.0677	0.0033	2	40	1	10	0.020	7	1.117	.	.
309	61208	CA1	62977	1112	85	55	8.0	0.64	0.584	0.0677	0.0033	2	40	1	10	0.020	5	2.579	.	.
310	61209	CA1	62977	1125	85	55	8.0	0.64	0.596	0.0677	0.0033	2	40	1	10	0.020	1	6.690	2.098	0.513
311	61209	CA1	62977	1125	85	55	8.0	0.64	0.596	0.0677	0.0033	2	40	1	10	0.020	4	6.519	2.8[illegible]	.
312	61209	CA1	62977	1125	85	55	8.0	0.64	0.584	0.0677	0.0033	2	40	1	10	0.020	7	1.141	.	.
313	61210	CA1	62977	1138	90	75	9.0	0.83	0.768	0.0717	0.0032	2	40	1	6	0.020	1	0.624	0.454	0.329
314	61210	CA1	62977	1138	90	75	8.0	0.83	0.758	0.0717	0.0032	2	40	1	6	0.020	4	0.713	0.616	.
315	61211	CA1	62977	1150	75	60	7.5	0.80	0.686	0.0367	0.0071	2	40	1	6	0.037	0	0.433	0.099	0.175
316	61211	CA1	62977	1150	75	60	7.5	0.80	0.737	0.0367	0.0071	2	40	1	6	0.037	3	1.819	0.161	.
317	61211	CA1	62977	1150	75	60	7.5	0.80	0.722	0.0367	0.0071	2	40	1	6	0.037	7	2.138	0.367	.
318	61212	CA1	62977	1235	80	55	7.2	0.68	0.591	0.0425	0.0071	2	40	1	6	0.037	1	7.519	1.520	0.323
319	61212	CA1	62977	1235	80	55	7.2	0.68	0.634	0.0425	0.0071	2	40	1	6	0.037	3	4.378	1.243	.
320	61214	CA1	62977	1300	90	65	6.0	0.72	0.621	0.0689	0.0081	2	26	1	4	0.037	2	1.239	0.695	0.111
321	61214	CA1	62977	1300	90	65	6.0	0.72	0.666	0.0689	0.0081	2	26	1	4	0.037	6	4.627	1.204	.
322	61214	CA1	62977	1300	90	65	6.0	0.72	0.666	0.0689	0.0081	2	26	1	4	0.037	10	6.829	.	.
323	61301	CA1	63077	1040	85	90	7.0	1.05	1.017	0.1770	0.0019	3	26	1	2	0.010	12	0.169	0.117	0.078
324	61301	CA1	63077	1040	85	90	7.0	1.05	1.017	0.1770	0.0019	3	26	1	2	0.010	16	0.762	0.254	.
325	61301	CA1	63077	1040	85	90	7.0	1.05	0.941	0.1770	0.0019	3	26	1	2	0.010	20	0.236	0.122	.
326	61302	CA1	63077	1050	80	70	8.0	0.87	0.861	0.3188	0.0006	3	26	1	2	0.004	2	0.123	0.130	0.093
327	61302	CA1	63077	1050	80	70	8.0	0.87	0.861	0.3188	0.0006	3	26	1	2	0.004	4	0.224	0.160	.
328	61302	CA1	63077	1050	80	70	8.0	0.87	0.861	0.3188	0.0006	3	26	1	2	0.004	7	1.343	0.207	.
329	61303	CA1	63077	1103	90	80	8.0	0.88	0.803	0.0573	0.0041	2	26	1	4	0.025	5	0.320	0.081	0.057

OBS	SERIES	STA	DATE	TIME	WHT	WVDPTH	PER	DOVERHB	BREKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
330	61303	CA1	63077	1103	90	80	8.0	0.88	0.874	0.0573	0.0041	2	26	1	4	0.025	16	0.797	0.359	.
331	61304	CA1	63077	1114	100	70	7.5	0.70	0.645	0.0907	0.0033	2	26	1	5	0.020	1	2.776	0.811	0.232
332	61304	CA1	63077	1114	100	70	7.5	0.70	0.532	0.0907	0.0033	2	26	1	5	0.020	4	0.440	0.249	.
333	61304	CA1	63077	1114	100	70	7.5	0.70	0.632	0.0907	0.0033	2	26	1	5	0.020	7	1.937	0.726	.
334	61305	CA1	63077	1135	70	60	7.5	0.85	0.790	0.0634	0.0039	3	26	1	5	0.020	2	0.342	0.261	0.251
335	61305	CA1	63077	1135	70	60	7.5	0.85	0.823	0.0634	0.0039	3	26	1	5	0.020	10	0.633	0.311	.
336	61306	CA1	63077	1146	70	60	7.5	0.85	0.790	0.0634	0.0039	3	26	1	6	0.020	1	0.376	0.267	0.127
337	61306	CA1	63077	1146	70	60	7.5	0.85	0.790	0.0634	0.0039	3	26	1	6	0.020	2	0.168	0.112	.
338	61307	CA1	63077	1201	70	65	7.5	0.92	0.856	0.0634	0.0039	3	24	1	6	0.020	1	0.099	0.111	0.091
339	61307	CA1	63077	1201	70	65	7.5	0.92	0.839	0.0634	0.0039	3	24	1	6	0.020	8	2.411	1.483	.
340	61308	CA1	63077	1258	70	55	6.0	0.78	0.575	0.0536	0.0092	2	24	1	5	0.037	2	0.886	1.603	0.398
341	61308	CA1	63077	1258	70	55	6.0	0.78	0.724	0.0536	0.0092	2	24	1	5	0.037	9	3.292	2.255	.
342	61401	BU2	70177	1120	125	120	9.0	0.96	0.922	0.1574	0.0012	1	60	1	3	0.010	20	0.114	0.114	0.144
343	61401	BU2	70177	1120	125	120	9.0	0.96	0.922	0.1574	0.0012	1	60	1	3	0.010	25	0.385	0.250	.
344	61401	BU2	70177	1120	125	120	9.0	0.96	0.849	0.1574	0.0012	1	60	1	3	0.010	30	0.144	0.149	.
345	61402	BU2	70177	1145	90	100	9.0	1.11	1.075	0.1417	0.0011	1	60	1	3	0.008	2	0.176	0.116	0.087
346	61402	BU2	70177	1145	90	100	9.0	1.11	1.071	0.1417	0.0011	1	60	1	3	0.008	7	0.355	0.120	.
347	61402	BU2	70177	1145	90	100	9.0	1.11	1.071	0.1417	0.0011	1	60	1	3	0.008	12	0.237	0.115	.
348	61403	BU2	70177	1203	90	100	9.0	1.11	0.987	0.0390	0.0042	1	10	1	3	0.029	8	0.201	0.160	0.103
349	61403	BU2	70177	1203	90	100	9.0	1.11	1.075	0.0390	0.0042	1	10	1	3	0.029	13	0.163	0.147	.
350	61403	BU2	70177	1203	90	100	9.0	1.11	1.071	0.0390	0.0042	1	10	1	3	0.029	18	0.187	0.137	.
351	61404	BU2	70177	1220	90	85	7.0	0.94	0.815	0.0520	0.0067	3	10	1	3	0.036	2	0.565	0.606	0.009
352	61404	BU2	70177	1220	90	85	7.0	0.94	0.878	0.0520	0.0067	3	10	1	3	0.036	7	0.688	0.555	.
353	61404	BU2	70177	1220	90	85	7.0	0.94	0.839	0.0520	0.0067	3	10	1	3	0.036	12	0.604	0.580	.
354	61405	BU2	70177	1312	80	85	6.0	1.06	0.936	0.0731	0.0072	3	33	1	5	0.031	5	0.093	0.091	0.118
355	61405	BU2	70177	1312	80	85	6.0	1.06	0.917	0.0731	0.0072	3	33	1	5	0.031	15	2.183	0.741	.
356	61406	BU2	70177	1330	75	70	6.0	0.93	0.822	0.0685	0.0074	3	33	1	5	0.031	0	0.698	0.592	0.334
357	61406	BU2	70177	1330	75	70	6.0	0.93	0.806	0.0685	0.0074	3	33	1	5	0.031	5	1.248	0.837	.
358	61406	BU2	70177	1330	75	70	6.0	0.93	0.806	0.0685	0.0074	3	33	1	5	0.031	9	0.982	0.799	.
359	61407	BU2	70177	1350	70	60	9.0	0.85	0.755	0.0284	0.0051	3	71	1	4	0.031	1	0.340	0.259	0.111
360	61407	BU2	70177	1350	70	60	9.0	0.85	0.740	0.0284	0.0051	3	71	1	4	0.031	11	0.585	0.406	.
361	61407	BU2	70177	1350	70	60	9.0	0.85	0.761	0.0284	0.0051	3	71	1	4	0.031	21	0.906	0.352	.
362	61408	BU2	70177	1405	80	70	4.5	0.87	0.771	0.1300	0.0096	3	62	1	4	0.031	2	1.587	1.034	0.816
363	61408	BU2	70177	1405	80	70	4.5	0.87	0.755	0.1300	0.0096	3	62	1	4	0.031	12	2.575	0.856	.
364	61408	BU2	70177	1405	80	70	4.5	0.87	0.777	0.1300	0.0096	3	62	1	4	0.031	22	1.073	.	.
365	61408	BU2	70177	1422	80	70	5.0	0.87	0.771	0.1053	0.0086	1	59	1	4	0.031	5	0.375	0.231	0.132
366	61408	BU2	70177	1422	80	70	5.0	0.87	0.755	0.1053	0.0086	1	59	1	4	0.031	15	2.435	1.706	.
367	61408	BU2	70177	1422	80	70	5.0	0.87	0.777	0.1053	0.0086	1	59	1	4	0.031	25	1.155	0.316	.
368	61501	CA1	70277	1122	115	95	13.0	0.82	0.768	0.0385	0.0016	3	0	0	0	0.018	2	0.328	0.109	0.086
369	61501	CA1	70277	1122	115	95	13.0	0.82	0.768	0.0385	0.0016	3	0	0	0	0.018	3	1.106	0.268	.
370	61501	CA1	70277	1122	115	95	13.0	0.82	0.768	0.0385	0.0016	3	0	0	0	0.018	4	0.158	0.111	.
371	61502	CA1	70277	1148	90	80	11.0	0.88	0.813	0.0329	0.0027	4	0	0	0	0.023	-1	0.636	0.339	0.245
372	61502	CA1	70277	1148	90	80	11.0	0.88	0.813	0.0329	0.0027	4	0	0	0	0.023	-1	0.208	0.172	.
373	61502	CA1	70277	1148	90	80	11.0	0.88	0.813	0.0329	0.0027	4	0	0	0	0.023	-1	0.394	0.120	.
374	61503	CA1	70277	1158	80	85	6.5	1.06	0.972	0.1756	0.0023	1	0	0	0	0.011	2	0.139	0.114	0.106
375	61503	CA1	70277	1158	80	85	6.5	1.06	0.972	0.1756	0.0023	1	0	0	0	0.011	2	0.610	0.195	.
376	61503	CA1	70277	1158	80	85	6.5	1.06	0.972	0.1756	0.0023	1	0	0	0	0.011	2	0.110	0.072	.

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERH	BRKFR	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
377	61504	CA1	70277	1208	95	95	7.0	1.00	0.952	0.3956	0.0009	1	0	0	0	0.005	5	0.132	0.099	0.058
378	61504	CA1	70277	1208	95	95	7.0	1.00	0.952	0.3956	0.0009	1	0	0	0	0.005	5	0.229	0.082	.
379	61504	CA1	70277	1208	95	95	7.0	1.00	0.952	0.3956	0.0009	1	0	0	0	0.005	5	0.812	0.211	.
380	61505	CA1	70277	1225	95	85	8.0	0.89	0.876	0.3029	0.0008	3	21	1	4	0.005	0	0.585	0.287	0.139
381	61505	CA1	70277	1225	95	85	8.0	0.89	0.876	0.3029	0.0008	3	21	1	4	0.005	0	1.157	0.254	.
382	61505	CA1	70277	1225	95	85	8.0	0.89	0.876	0.3029	0.0008	3	21	1	4	0.005	0	0.377	0.216	.
383	61506	CA1	70277	1235	100	90	9.0	0.90	0.882	0.0503	0.0034	2	21	1	4	0.025	5	0.601	0.392	0.211
384	61506	CA1	70277	1235	100	90	9.0	0.90	0.882	0.0503	0.0034	2	21	1	4	0.025	5	0.665	0.489	.
385	61506	CA1	70277	1235	100	90	9.0	0.90	0.882	0.0503	0.0034	2	21	1	4	0.025	5	.	0.350	.
386	61507	CA1	70277	1250	110	85	11.0	0.77	0.692	0.0343	0.0029	2	21	1	4	0.027	2	0.778	0.241	0.084
387	61507	CA1	70277	1250	110	85	11.0	0.77	0.692	0.0343	0.0029	2	21	1	4	0.027	2	1.774	0.570	.
388	61507	CA1	70277	1250	110	85	11.0	0.77	0.692	0.0343	0.0029	2	21	1	4	0.027	2	0.274	0.140	.
389	61508	CA1	70277	1409	90	60	10.0	0.66	0.575	0.0340	0.0035	2	21	1	4	0.027	2	2.248	0.289	0.261
390	61508	CA1	70277	1409	90	60	10.0	0.66	0.575	0.0340	0.0035	2	21	1	4	0.027	4	3.036	0.738	.
391	61508	CA1	70277	1409	90	60	10.0	0.66	0.585	0.0340	0.0035	2	21	1	4	0.027	7	2.218	1.680	.
392	61509	CA1	70277	1423	80	65	10.0	0.81	0.701	0.0233	0.0048	3	21	1	4	0.035	4	0.179	0.123	0.049
393	61509	CA1	70277	1423	80	65	10.0	0.81	0.704	0.0233	0.0048	3	21	1	4	0.035	6	0.427	0.124	.
394	61510	CA1	70277	1430	70	55	10.0	0.78	0.678	0.0198	0.0053	4	21	1	4	0.036	0	0.351	0.280	0.126
395	61510	CA1	70277	1430	70	55	10.0	0.78	0.684	0.0198	0.0053	2	21	1	4	0.036	2	1.615	0.950	.
396	61510	CA1	70277	1430	70	55	10.0	0.78	0.689	0.0198	0.0053	2	21	1	4	0.036	5	1.937	0.483	.
397	61511	CA1	70277	1455	75	60	10.0	0.80	0.690	0.0212	0.0051	3	21	1	4	0.036	1	0.858	0.779	0.544
398	61511	CA1	70277	1455	75	60	10.0	0.80	0.693	0.0212	0.0051	3	21	1	4	0.036	5	1.049	0.864	.
399	61512	CA1	70277	1503	80	60	10.0	0.75	0.647	0.0226	0.0050	2	21	1	4	0.036	1	0.546	0.158	0.129
400	61512	CA1	70277	1503	80	60	10.0	0.75	0.647	0.0226	0.0050	2	21	1	4	0.036	3	0.714	0.317	.
401	61512	CA1	70277	1503	80	60	10.0	0.75	0.650	0.0226	0.0050	2	21	1	4	0.036	6	5.342	1.536	.
402	61601	BU2	70477	1104	110	100	7.0	0.90	0.869	0.2082	0.0018	1	33	2	3	0.011	5	0.138	0.106	0.095
403	61601	BU2	70477	1104	110	100	7.0	0.90	0.869	0.2082	0.0018	1	33	2	3	0.011	8	0.734	0.268	.
404	61601	BU2	70477	1104	110	100	7.0	0.90	0.898	0.2082	0.0018	1	33	2	3	0.011	11	0.762	0.279	.
405	61602	BU2	70477	1117	130	120	8.5	0.92	0.883	0.0765	0.0030	1	33	2	3	0.024	5	0.094	0.053	0.063
406	61602	BU2	70477	1117	130	120	8.5	0.92	0.883	0.0765	0.0030	1	33	2	3	0.024	8	0.115	0.079	.
407	61602	BU2	70477	1117	130	120	8.5	0.92	0.883	0.0765	0.0030	1	33	2	3	0.024	12	0.195	0.083	.
408	61603	BU2	70477	1139	115	110	7.5	0.95	0.867	0.0869	0.0037	1	33	2	3	0.024	5	0.156	0.074	0.062
409	61603	BU2	70477	1139	115	110	7.5	0.95	0.915	0.0869	0.0037	1	33	2	3	0.024	7	1.538	0.081	.
410	61603	BU2	70477	1139	115	110	7.5	0.95	0.915	0.0869	0.0037	1	33	2	3	0.024	10	2.625	0.187	.
411	61604	BU2	70477	1154	110	105	8.0	0.95	0.866	0.0923	0.0028	1	17	2	3	0.019	4	0.294	0.167	0.150
412	61604	BU2	70477	1154	110	105	8.0	0.95	0.913	0.0923	0.0028	1	17	2	3	0.019	7	0.276	0.246	.
413	61604	BU2	70477	1154	110	105	8.0	0.95	0.913	0.0923	0.0028	1	17	2	3	0.019	10	0.628	0.371	.
414	61605	BU2	70477	1224	90	90	10.0	1.00	0.926	0.0483	0.0025	4	15	2	3	0.019	-1	0.096	0.092	0.120
415	61605	BU2	70477	1224	90	90	10.0	1.00	0.907	0.0483	0.0025	1	15	2	3	0.019	2	0.204	0.199	.
416	61605	BU2	70477	1224	90	90	10.0	1.00	0.907	0.0483	0.0025	1	15	2	3	0.019	5	0.189	0.139	.
417	61606	BU2	70477	1246	95	95	6.5	1.00	0.926	0.1207	0.0037	1	15	2	3	0.019	4	0.074	0.047	0.044
418	61606	BU2	70477	1246	95	95	6.5	1.00	0.907	0.1207	0.0037	1	15	2	3	0.019	9	0.196	0.058	.
419	61606	BU2	70477	1246	95	95	6.5	1.00	0.956	0.1207	0.0037	1	15	2	3	0.019	13	0.349	0.207	.
420	61607	BU2	70477	1343	40	45	7.0	1.12	1.046	0.0260	0.0090	4	15	2	3	0.032	-5	0.089	0.056	0.039
421	61607	BU2	70477	1343	40	45	7.0	1.12	1.046	0.0260	0.0090	4	15	2	3	0.032	-2	0.062	0.055	.
422	61607	BU2	70477	1343	40	45	7.0	1.12	0.991	0.0260	0.0090	1	15	2	3	0.032	1	0.218	0.231	.
423	61608	BU2	70477	1354	80	70	10.0	0.87	0.813	0.0255	0.0044	1	15	2	3	0.032	3	0.429	0.372	0.271

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERH	BRKFR	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
424	61608	BU2	70477	1354	80	70	10.0	0.87	0.813	0.0255	0.0044	1	15	2	3	0.032	5	1.081	0.720	.
425	61608	BU2	70477	1354	80	70	10.0	0.87	0.771	0.0255	0.0044	1	15	2	3	0.032	10	0.638	0.443	.
426	61609	BU2	70477	1405	75	75	7.0	1.00	0.878	0.1115	0.0028	3	15	2	3	0.014	1	0.708	0.421	0.222
427	61609	BU2	70477	1405	75	75	7.0	1.00	0.878	0.1115	0.0028	3	15	2	3	0.014	4	0.920	0.428	.
428	61609	BU2	70477	1405	75	75	7.0	1.00	0.929	0.1115	0.0028	3	15	2	3	0.014	6	0.459	0.302	.
429	61610	BU2	70477	1418	85	80	10.0	0.94	0.809	0.0619	0.0018	1	15	2	3	0.014	3	0.282	0.236	.
430	61610	BU2	70477	1418	85	80	10.0	0.94	0.826	0.0619	0.0018	1	15	2	3	0.014	6	0.205	0.215	.
431	61611	BU2	70477	1431	80	85	8.0	1.06	1.004	0.4251	0.0005	1	15	2	4	0.003	5	0.266	0.158	0.103
432	61611	BU2	70477	1431	80	85	8.0	1.06	1.004	0.4251	0.0005	1	15	2	4	0.003	8	0.068	0.066	.
433	61611	BU2	70477	1431	80	85	8.0	1.06	0.932	0.4251	0.0005	1	15	2	4	0.003	12	0.848	0.297	.
434	61701	BU2	70577	947	95	90	8.0	0.94	0.835	0.0488	0.0049	3	0	0	0	0.031	0	0.151	0.101	0.069
435	61701	BU2	70577	947	95	90	8.0	0.94	0.835	0.0488	0.0049	3	0	0	0	0.031	3	0.221	0.155	.
436	61701	BU2	70577	947	95	90	8.0	0.94	0.877	0.0488	0.0049	3	0	0	0	0.031	7	0.835	0.514	.
437	61702	BU2	70577	1000	90	85	8.0	0.94	0.832	0.0462	0.0051	3	0	0	0	0.031	1	0.694	0.423	0.332
438	61702	BU2	70577	1000	90	85	8.0	0.94	0.874	0.0462	0.0051	3	0	0	0	0.031	5	1.089	0.422	.
439	61702	BU2	70577	1000	90	85	8.0	0.94	0.856	0.0462	0.0051	3	0	0	0	0.031	9	0.261	0.218	.
440	61703	BU2	70577	1014	100	90	8.0	0.90	0.833	0.0839	0.0029	3	0	0	0	0.019	0	0.557	0.749	0.465
441	61703	BU2	70577	1014	100	90	8.0	0.90	0.816	0.0839	0.0029	3	0	0	0	0.019	4	0.546	0.417	.
442	61703	BU2	70577	1014	100	90	8.0	0.90	0.816	0.0839	0.0029	3	0	0	0	0.019	8	.	0.813	.
443	61704	BU2	70577	1026	100	95	8.0	0.95	0.862	0.0664	0.0037	2	0	0	0	0.024	1	0.326	0.167	0.024
444	61704	BU2	70577	1026	100	95	8.0	0.95	0.862	0.0664	0.0037	2	0	0	0	0.024	4	0.148	0.114	.
445	61704	BU2	70577	1026	100	95	8.0	0.95	0.908	0.0664	0.0037	2	0	0	0	0.024	7	0.242	0.104	.
446	61705	BU2	70577	1040	90	85	8.0	0.94	0.856	0.0597	0.0039	3	0	0	0	0.024	0	0.114	0.077	0.070
447	61705	BU2	70577	1040	90	85	8.0	0.94	0.903	0.0597	0.0039	3	0	0	0	0.024	3	0.234	0.261	.
448	61705	BU2	70577	1040	90	85	8.0	0.94	0.903	0.1304	0.0018	3	0	0	0	0.011	5	0.245	0.229	.
449	61706	BU2	70577	1052	90	85	8.5	0.94	0.963	0.0529	0.0037	3	0	0	0	0.024	2	0.329	0.256	0.135
450	61706	BU2	70577	1052	90	85	8.5	0.94	0.933	0.0529	0.0037	3	0	0	0	0.024	6	0.231	0.170	.
451	61707	BU2	70577	1105	95	85	7.5	0.89	0.856	0.0861	0.0034	3	0	0	0	0.020	2	0.127	0.085	0.080
452	61707	BU2	70577	1105	95	85	7.5	0.89	0.856	0.0861	0.0034	3	0	0	0	0.020	4	0.143	0.131	.
453	61708	BU2	70577	1211	85	80	8.0	0.94	0.900	0.1232	0.0018	1	0	0	0	0.011	1	0.317	0.207	0.147
454	61801	CA1	70677	1104	130	130	5.0	1.00	0.956	0.3537	0.0032	1	18	2	2	0.015	5	0.085	0.067	0.047
455	61801	CA1	70677	1104	130	130	5.0	1.00	0.968	0.3537	0.0032	1	18	2	2	0.015	9	0.078	0.043	.
456	61801	CA1	70677	1104	130	130	5.0	1.00	0.988	0.3537	0.0032	1	18	2	2	0.015	14	0.608	0.193	.
457	61802	CA1	70677	1125	145	135	5.5	0.93	0.876	0.2574	0.0035	1	18	2	2	0.019	7	0.075	0.078	0.063
458	61802	CA1	70677	1125	145	135	5.5	0.93	0.824	0.2574	0.0035	1	18	2	2	0.019	13	0.470	0.189	.
459	61802	CA1	70677	1125	145	135	5.5	0.93	0.862	0.2574	0.0035	1	18	2	2	0.019	17	0.302	.	.
460	61803	CA1	70677	1143	120	125	5.0	1.04	0.980	0.3265	0.0034	1	18	2	2	0.015	1	0.067	0.052	0.037
461	61803	CA1	70677	1143	120	125	5.0	1.04	0.922	0.3265	0.0034	1	18	2	2	0.015	4	0.091	0.058	.
462	61804	CA1	70677	1202	140	130	5.0	0.92	0.822	0.3809	0.0031	1	18	2	2	0.015	3	0.106	0.080	0.075
463	61804	CA1	70677	1202	140	130	5.0	0.92	0.859	0.3809	0.0031	1	18	2	2	0.015	13	0.362	0.202	.
464	61805	CA1	70677	1215	120	110	5.0	0.91	0.811	0.3265	0.0034	4	18	2	2	0.015	-7	0.181	0.092	0.077
465	61805	CA1	70677	1215	120	110	5.0	0.91	0.811	0.3265	0.0034	4	18	2	2	0.015	-3	0.099	0.071	.
466	61805	CA1	70677	1215	120	110	5.0	0.91	0.848	0.3265	0.0034	1	18	2	2	0.015	1	0.105	0.203	.
467	61806	CA1	70677	1230	120	115	4.0	0.95	0.848	0.2551	0.0085	4	18	2	2	0.030	-2	0.106	0.095	0.063
468	61806	CA1	70677	1230	120	115	4.0	0.95	0.987	0.2551	0.0085	4	18	2	2	0.030	5	0.123	0.098	.
469	61807	CA1	70677	1244	115	105	4.5	0.91	0.845	0.3049	0.0049	3	18	2	2	0.019	0	0.246	0.213	0.198
470	61807	CA1	70677	1244	115	105	4.5	0.91	0.845	0.3049	0.0049	3	18	2	2	0.019	4	0.709	0.595	.

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERHB	BRKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
471	61807	CA1	70677	1244	115	105	4.5	0.91	0.835	0.305	0.00491	3	18	2	2	0.019	8	0.507	0.337	.
472	61808	CA1	70677	1330	110	110	4.5	1.00	0.926	0.307	0.0047[illegible]	1	34	2	2	0.018	4	0.111	0.067	0.065
473	61808	CA1	70677	1330	110	110	4.5	1.00	0.926	0.307	0.0047[illegible]	1	34	2	2	0.018	8	0.285	0.105	.
474	61808	CA1	70677	1330	110	110	4.5	1.00	0.914	0.307	0.0047[illegible]	1	34	2	2	0.018	12	0.163	0.159	.
475	61809	CA1	70677	1345	125	140	5.0	1.12	0.991	0.283	0.0040	1	34	2	3	0.018	5	0.072	0.077	0.076
476	61809	CA1	70677	1345	125	140	5.0	1.12	0.991	0.283	0.0040	1	34	2	3	0.018	8	0.295	0.161	.
477	61811	CA1	70677	1415	100	90	5.0	0.90	0.796	0.226	0.0044	3	34	2	5	0.018	1	0.248	0.182	0.158
478	61811	CA1	70677	1415	100	90	5.0	0.90	0.823	0.226	0.0044	3	34	2	5	0.018	11	0.090	0.229	.
479	61811	CA1	70677	1415	100	90	5.0	0.90	0.850	0.226	0.0044	3	34	2	5	0.018	23	0.716	0.180	.
480	61812	CA1	70677	1425	105	95	5.0	0.90	0.837	0.238	0.0043	3	40	2	5	0.018	2	0.745	0.419	0.065
481	61812	CA1	70677	1425	105	95	5.0	0.90	0.834	0.238	0.0043	3	40	2	5	0.018	26	1.278	0.662	.
482	61901	CA1	70777	1145	105	100	6.0	0.95	0.896	0.165	0.0036	3	32	1	5	0.018	3	1.381	0.165	0.079
483	61901	CA1	70777	1145	105	100	6.0	0.95	0.843	0.165	0.0036	3	32	1	5	0.018	8	3.224	1.452	.
484	61901	CA1	70777	1145	105	100	6.0	0.95	0.862	0.165	0.0036	3	32	1	5	0.018	11	0.344	0.205	.
485	61902	CA1	70777	1155	145	140	6.0	0.96	0.908	0.241	0.0029	1	32	1	5	0.017	8	0.342	0.084	0.067
486	61902	CA1	70777	1155	145	140	6.0	0.96	0.854	0.241	0.0029	1	32	1	5	0.017	13	0.061	0.067	.
487	61903	CA1	70777	1215	120	120	6.0	1.00	0.885	0.200	0.0032	1	32	1	5	0.017	5	0.135	0.135	0.109
488	61903	CA1	70777	1215	120	120	6.0	1.00	0.926	0.200	0.0032	1	32	1	5	0.017	8	0.727	0.220	.
489	61903	CA1	70777	1215	120	120	6.0	1.00	0.926	0.200	0.0032	1	32	1	5	0.017	11	0.251	0.136	.
490	61904	CA1	70777	1235	105	110	5.0	1.04	0.974	0.238	0.0043	1	32	1	5	0.018	4	0.132	0.150	0.157
491	61904	CA1	70777	1235	105	110	5.0	1.04	0.970	0.238	0.0043	1	32	1	5	0.018	8	0.162	0.157	.
492	61906	CA1	70777	1342	110	110	5.0	1.00	0.926	0.249	0.0042	1	32	1	5	0.018	4	0.104	0.096	0.102
493	61906	CA1	70777	1342	110	110	5.0	1.00	0.914	0.249	0.0042	1	32	1	5	0.018	10	0.394	0.254	.
494	61906	CA1	70777	1342	110	110	5.0	1.00	0.914	0.249	0.0042	1	32	1	5	0.018	14	0.721	0.306	.
495	61907	CA1	70777	1357	95	100	6.0	1.05	0.963	0.107	0.0053	1	37	1	5	0.025	5	1.047	0.780	0.631
496	61907	CA1	70777	1357	95	100	6.0	1.05	0.994	0.107	0.0053	1	37	1	5	0.025	15	0.858	0.411	.
497	61908	CA1	70777	1410	90	85	6.0	0.94	0.892	0.102	0.0054	3	37	1	5	0.025	8	1.015	0.715	0.455
498	61908	CA1	70777	1410	90	85	6.0	0.94	0.871	0.102	0.0054	3	37	1	5	0.025	13	0.721	0.556	.
499	61908	CA1	70777	1410	90	85	6.0	0.94	0.829	0.102	0.0054	3	37	1	5	0.025	18	0.457	.	.
500	61909	CA1	70777	1420	.	.	6.0	.	.	.	.	1	37	1	5	0.025	15	0.255	0.195	.
501	61909	CA1	70777	1420	.	.	6.0	.	.	.	.	1	37	1	5	0.025	20	0.214	.	.
502	61909	CA1	70777	1420	.	.	6.0	.	.	.	.	1	37	1	5	0.025	25	0.184	.	.
503	61910	CA1	70777	1430	.	.	11.0	.	.	.	.	1	37	1	5	0.045	.	0.194	.	.
504	61910	CA1	70777	1430	.	.	11.0	.	.	.	.	1	37	1	5	0.045	.	11.845	.	.
505	62001	BU2	70877	1135	120	130	5.5	1.08	1.049	0.505	0.0016	1	64	1	3	0.008	2	0.099	0.069	0.070
506	62001	BU2	70877	1135	120	130	5.5	1.08	1.049	0.505	0.0016	1	64	1	3	0.008	10	0.182	0.132	.
507	62001	BU2	70877	1135	120	130	5.5	1.08	1.070	0.505	0.0016	1	64	1	3	0.008	17	0.165	0.146	.
508	62002	BU2	70877	1150	110	115	5.3	1.04	1.032	1.331	0.0006	1	64	1	3	0.003	6	0.177	0.119	0.103
509	62002	BU2	70877	1150	110	115	5.3	1.04	0.988	1.331	0.0006	1	64	1	3	0.003	9	0.203	0.024	0.135
510	62003	BU2	70877	1200	95	95	5.3	1.00	0.878	0.156	0.0053	3	64	1	2	0.022	2	0.329	0.305	0.375
511	62003	BU2	70877	1200	95	95	5.3	1.00	0.929	0.156	0.0053	3	64	1	2	0.022	7	0.496	0.451	0.300
512	62003	BU2	70877	1200	95	95	5.3	1.00	0.881	0.156	0.0053	3	64	1	2	0.022	12	1.103	0.914	.
513	62004	BU2	70877	1212	85	80	5.0	0.94	0.829	0.138	0.0067	3	64	1	3	0.025	2	0.355	0.308	0.243
514	62004	BU2	70877	1212	85	80	5.0	0.94	0.829	0.138	0.0067	3	64	1	3	0.025	7	0.988	0.382	.
515	62004	BU2	70877	1212	85	80	5.0	0.94	0.871	0.138	0.0067	3	64	1	3	0.025	12	0.994	.	.
516	62005	BU2	70877	1222	.	.	5.0	.	.	.	.	3	64	1	3	0.022	.	0.398	0.343	.
517	62005	BU2	70877	1222	.	.	5.0	.	.	.	.	3	64	1	3	0.022	.	0.886	.	.

OBS	SERIES	STA	DATE	TIME	WVHT	WVDPTH	PER	DOVERHB	BRKER	HB	XI	WVTYPE	LSCUR	LSDIR	ALPHAB	MOFF	CRSTDIS	SS10	SS30	SS60
518	62005	BU2	70877	1222	.	.	5	.	.	.	.	3	64	1	3	0.022	.	0.469	.	.
519	62006	BU2	70877	1230	.	.	5	.	.	.	.	3	64	1	3	0.022	.	1.757	0.996	.
520	62006	BU2	70877	1230	.	.	5	.	.	.	.	3	64	1	3	0.022	.	1.417	.	.
521	62007	BU2	70877	1238	.	.	5	.	.	.	.	1	42	1	3	0.022	.	0.181	.	.
522	62007	BU2	70877	1239	.	.	5	.	.	.	.	1	42	1	3	0.022	.	0.710	.	.
523	62008	BU2	70877	1250	140	135	5	0.96	0.952	0.259	0.0046	1	42	1	3	0.022	3	0.253	0.105	0.130
524	62102	CA1	70977	1116	85	70	6	0.82	0.732	0.068	0.0079	2	7	1	2	0.035	1	0.927	0.595	0.200
525	62102	CA1	70977	1116	85	70	6	0.82	0.732	0.068	0.0079	2	7	1	2	0.035	1	0.849	1.256	0.513
526	62105	CA1	70977	1210	100	95	6	0.95	0.931	0.113	0.0052	2	7	1	2	0.025	4	0.233	0.172	0.146
527	62105	CA1	70977	1210	100	95	6	0.95	0.901	0.113	0.0052	2	7	1	2	0.025	9	0.184	0.150	0.180
528	62105	CA1	70977	1210	100	95	6	0.95	0.890	0.113	0.0052	2	7	1	2	0.025	14	0.190	0.135	0.170

APPENDIX C - 1. Suspended Sediment Grain Size Data - 1977.
2. Representative Size Frequency Curves by Sample Position.

Code	Definition
STA	STATION IDENTIFICATION
DATE	DATE - month, day, year
SERIES	NUMBER ASSIGNED - to each wave sampled
WVHT	BREAKER HEIGHT - cm
WVTYPE	VISUAL WAVE TYPE - 1=spilling 2=plunging 3=transition
DIS	DISTANCE FROM BENCHMARK ON LAND - m
HT	SAMPLE ELEVATION ABOVE BED - cm
MZ	MEAN GRAIN SIZE - ϕ
STDDEV	STANDARD DEVIATION - ϕ
SKEW	SKEWNESS
KURT	KURTOSIS
SS	SUSPENDED SEDIMENT CONCENTRATION - g/l.

OBS	STA	DATE	SERIES	WVHT	WVTYPE	DIS	HT	MZ	STDDEV	SKEW	KURT	SS
1	CA1	61477	604012	80	3	80	10	3.34	0.347	-0.170	-0.402	0.798
2	CA1	61477	604031	80	1	95	10	3.04	0.752	-0.754	2.439	.
3	CA1	61677	606073	45	1	105	30	3.13	0.443	-0.794	3.422	.
4	CA1	61677	606073	45	1	105	10	3.21	0.619	-0.990	5.551	.
5	PI1	61877	607023	40	1	55	10	3.02	0.649	-0.539	2.423	.
6	PI1	61877	607053	25	3	51	10	3.07	0.542	-0.462	1.184	.
7	CA1	62977	612052	55	2	108	30	3.32	0.342	-0.169	1.371	1.084
8	CA1	62977	612052	55	2	108	10	3.06	0.610	-0.877	4.671	3.323
9	CA1	62977	612062	45	2	114	30	3.34	0.346	-1.781	34.368	0.928
10	CA1	62977	612062	45	2	114	10	3.30	0.242	-0.216	0.487	1.067
11	CA1	62977	612063	35	2	110	30	3.30	0.242	0.370	0.382	1.472
12	CA1	62977	612063	35	2	110	10	3.31	0.292	0.091	0.411	1.599
13	CA1	62977	612072	35	2	115	10	3.08	0.922	-1.003	3.673	1.117
14	CA1	62977	612073	65	2	116	30	3.31	0.349	-0.408	2.989	1.172
15	CA1	62977	612073	65	2	118	10	3.01	0.749	-0.912	4.128	6.255
16	CA1	62977	612082	60	2	116	10	3.11	0.536	-0.696	1.622	2.579
17	CA1	62977	612083	50	2	115	30	2.91	0.711	-0.490	0.177	1.764
18	CA1	62977	612083	50	2	115	10	3.08	0.318	0.052	0.470	9.026
19	CA1	62977	612092	35	2	118	10	3.25	0.438	-0.518	2.566	1.141
20	CA1	62977	612093	45	2	121	30	3.26	0.271	0.105	-0.579	2.875
21	CA1	62977	612093	45	2	121	10	3.11	0.577	-0.718	3.020	6.519
22	CA1	62977	612091	85	2	124	30	3.21	0.509	-0.756	2.318	2.098
23	CA1	62977	612091	85	2	124	10	3.12	0.719	-0.856	2.743	6.690
24	CA1	62977	612103	30	3	120	30	3.35	0.286	-0.551	2.891	0.616
25	CA1	62977	612103	30	3	120	10	3.12	0.629	-0.714	1.920	0.713
26	CA1	62977	612122	45	2	124	30	3.17	0.396	-0.203	-0.054	1.243
27	CA1	62977	612122	45	2	124	10	3.16	0.603	-0.999	6.384	4.378
28	CA1	62977	612123	35	2	122	30	2.43	1.037	0.076	-1.541	0.719
29	CA1	62977	612123	35	2	122	10	2.91	0.922	-0.779	1.925	8.600
30	CA1	62977	612142	50	2	122	30	3.18	0.840	-1.079	5.049	1.204
31	CA1	62977	612142	50	2	122	10	3.08	0.699	-0.875	3.787	4.627
32	CA1	62977	612143	35	2	118	10	2.78	0.632	-0.302	0.454	6.829
33	CA1	63077	613043	45	2	114	30	3.04	0.699	-0.832	1.105	0.726
34	CA1	63077	613043	45	2	114	10	3.19	0.510	-0.367	0.235	1.937
35	CA1	63077	613053	50	3	116	30	3.07	0.562	-0.522	0.710	0.311
36	CA1	63077	613053	50	3	116	10	3.21	0.679	-0.725	1.546	0.633
37	CA1	63077	613063	40	3	117	30	3.52	0.170	-0.062	-0.856	0.112
38	CA1	63077	613063	40	3	117	10	3.39	0.238	-0.017	-0.431	0.168
39	CA1	63077	613072	35	2	118	30	3.24	0.461	-0.572	0.862	0.111
40	CA1	63077	613072	35	2	118	10	3.09	0.636	-0.757	1.680	0.099
41	CA1	63077	613073	40	2	122	30	3.12	0.754	-0.767	2.625	1.483
42	CA1	63077	613073	40	2	122	10	3.30	0.476	-0.153	-0.440	2.411
43	CA1	63077	613082	30	2	121	30	3.27	0.541	-0.427	0.537	1.603
44	CA1	63077	613082	30	2	121	10	3.23	0.432	-0.794	7.870	0.886
45	CA1	63077	613083	40	2	125	30	3.19	0.482	-0.214	0.014	2.255
46	CA1	63077	613083	40	2	125	10	3.05	0.608	-0.749	3.673	3.292
47	CA1	63077	613102	40	2	119	10	3.39	0.317	-0.075	-0.756	.
48	CA1	63077	613101	40	2	122	10	2.52	0.646	-0.223	-0.412	.
49	CA1	63077	613033	90	2	110	10	2.86	0.603	-0.337	1.001	0.797
50	CA1	70277	615082	40	2	121	30	3.08	0.707	-0.750	2.428	1.680
51	CA1	70277	615082	40	2	121	10	3.16	0.417	-0.390	0.930	2.218
52	CA1	70277	615083	65	2	124	30	3.25	0.864	-0.964	2.912	0.738
53	CA1	70277	615083	65	2	124	10	3.14	0.687	-0.600	1.677	3.036
54	CA1	70277	615123	50	2	125	30	3.08	0.783	-1.126	5.162	1.536

OBS	STA	DATE	SERIES	WVHT	WVTYPE	DIS	HT	MZ	STDDEV	SKEW	KURT	SS
55	CA1	70277	615123	50	2	125	10	3.09	0.335	0.128	0.144	5.342
56	CA1	70977	619013	75	1	74	30	3.06	0.512	-0.874	2.742	0.132
57	CA1	70977	619013	75	1	74	10	3.05	0.524	-0.501	0.750	0.182
58	CA1	70977	619102	22	1	25	10	3.12	0.235	0.167	-0.523	.
59	CA1	70977	621012	105	2	120	60	3.17	0.560	-1.427	11.791	.
60	CA1	70977	621012	105	2	120	30	3.14	0.594	-1.017	4.195	.
61	CA1	70977	621012	105	2	120	10	3.26	0.355	-0.466	3.930	.
62	CA1	70977	621013	100	2	115	60	3.44	0.310	-0.173	-0.589	.
63	CA1	70977	621013	100	2	115	30	3.19	0.393	-0.206	-0.331	.
64	CA1	70977	621013	100	2	115	10	3.13	0.453	-1.000	7.644	.
65	PI1	61877	607083	8	2	65	10	3.16	0.398	-0.164	0.279	.
66	PI1	61877	607092	35	1	93	10	3.09	0.689	-0.992	4.600	0.332
67	PI1	61877	607122	35	1	120	10	3.31	0.520	-0.924	4.586	1.154
68	PI1	61877	607123	35	1	115	10	3.47	0.515	-1.937	20.072	0.556
69	PI1	62177	610023	35	2	52	10	2.65	0.559	-0.444	0.105	1.948
70	PI1	62177	610033	35	2	51	10	2.88	0.587	-0.534	1.708	6.717
71	PI1	62177	610043	25	2	55	10	2.68	0.582	-0.615	2.990	2.696
72	PI1	62177	610053	15	3	54	10	3.08	0.472	-0.328	0.830	1.595
73	BU2	61277	602022	30	2	102	10	2.99	0.541	-0.030	-0.692	0.441
74	BU2	61277	602042	25	3	101	30	3.08	0.695	-0.249	-0.804	0.099
75	BU2	61277	602042	25	3	101	10	3.04	0.629	-0.269	-0.756	0.115
76	BU2	61277	602052	50	2	104	30	3.49	0.211	0.038	-1.594	0.275
77	BU2	61277	602052	50	2	104	10	3.39	0.398	-0.380	0.336	0.528
78	BU2	61277	602062	55	3	100	30	3.43	0.378	-0.296	-1.064	0.120
79	BU2	61277	602062	55	3	100	10	3.63	0.237	-0.059	-0.903	0.220
80	BU2	61277	602102	30	2	75	10	3.23	0.381	0.033	-1.049	0.711
81	BU2	61577	605022	70	2	99	30	3.66	0.124	-0.194	-1.336	1.350
82	BU2	61577	605022	70	2	99	10	3.41	0.518	-1.197	6.313	7.410
83	BU2	61577	605023	70	2	99	30	3.63	0.326	-2.466	47.523	1.209
84	BU2	61577	605023	70	2	99	10	3.34	0.630	-1.170	7.399	1.463
85	BU2	61577	605021	70	2	99	30	3.29	0.741	-1.386	6.045	0.801
86	BU2	61577	605021	70	2	99	10	3.37	0.585	-1.262	6.793	1.266
87	BU2	61577	605032	70	2	99	10	3.14	0.869	-0.989	4.083	1.766
88	BU2	61577	605032	70	2	99	30	3.17	0.893	-0.813	1.686	1.049
89	BU2	61577	605033	70	2	99	10	3.30	0.507	-0.973	5.404	1.453
90	BU2	61577	605031	70	2	99	30	3.38	0.554	-0.770	2.685	1.810
91	BU2	61577	605031	70	2	99	10	3.28	0.501	-0.871	4.967	2.694
92	BU2	61577	605042	45	2	100	30	3.32	0.559	-0.878	4.308	3.121
93	BU2	61577	605042	45	2	100	10	3.45	0.367	-1.037	7.446	9.215
94	BU2	61577	605043	45	2	100	30	3.22	0.639	-0.727	1.873	2.206
95	BU2	61577	605043	45	2	100	10	3.15	0.801	-0.893	3.040	5.778
96	BU2	61577	605041	45	2	100	30	3.45	0.277	0.019	0.063	9.221
97	BU2	61577	605041	45	2	100	10	3.20	0.747	-0.996	4.255	9.999
98	BU2	61577	605052	40	2	101	30	3.64	0.165	0.356	-0.563	0.541
99	BU2	61577	605052	40	2	101	10	3.36	0.692	-1.501	10.237	0.599
100	BU2	61577	605053	40	2	101	30	3.27	0.686	-0.411	-0.157	0.650
101	BU2	61577	605053	40	2	101	10	3.01	1.158	-0.704	0.620	1.090
102	BU2	61577	605062	35	2	101	30	3.52	0.211	0.235	-0.343	1.945
103	BU2	61577	605062	35	2	101	10	3.34	0.433	-1.432	13.635	2.614
104	BU2	61577	605061	35	2	101	30	3.38	0.362	-0.445	2.934	0.895
105	BU2	61577	605061	35	2	101	10	3.47	0.307	-0.354	1.355	1.753
106	BU2	61577	605073	30	2	101	10	3.06	0.901	-0.671	0.945	2.642
107	BU2	61577	605071	30	2	101	30	3.24	0.464	-1.426	16.237	2.158
108	BU2	61577	605073	30	2	101	30	3.34	0.310	-0.334	0.634	1.513
OBS	STA	DATE	SERIES	WVHT	WVTYPE	DIS	HT	MZ	STDDEV	SKEW	KURT	SS
109	BU2	61577	605071	30	2	101	10	3.15	0.782	-1.065	4.675	2.618
110	BU2	62877	611023	50	2	140	10	3.24	0.598	-0.806	4.198	1.342
111	BU2	62877	611052	20	2	111	10	3.62	0.263	0.005	-1.167	1.558
112	BU2	62877	611053	20	2	111	10	2.79	0.819	-0.533	0.933	1.094
113	BU2	62877	611062	15	3	115	10	2.31	0.970	0.047	-1.272	7.071
114	BU2	62877	611063	30	3	109	10	3.25	0.476	-0.426	2.307	4.197
115	BU2	62877	611061	20	3	112	30	3.53	0.384	-0.349	-0.255	0.575
116	BU2	62877	611061	20	3	112	10	3.35	0.543	-1.287	10.327	0.981
117	BU2	62877	611073	15	3	106	10	1.14	0.866	0.726	1.590	0.429
118	BU2	62877	611082	20	5	106	10	3.09	0.672	-0.308	-0.766	6.154
119	BU2	62877	611083	20	5	109	10	3.27	0.565	-0.992	5.955	2.592
120	BU2	62877	611081	25	5	112	30	2.85	0.892	-0.530	0.405	0.543
121	BU2	62877	611081	25	5	112	10	3.21	0.797	-1.151	5.535	1.469
122	BU2	70177	614042	65	3	140	30	3.08	0.899	-0.569	0.596	0.580
123	BU2	70177	614042	65	3	140	10	3.28	0.678	-0.778	1.806	0.604
124	BU2	70177	614043	60	3	145	30	3.26	0.889	-1.317	5.414	0.555
125	BU2	70177	614043	60	3	145	10	3.49	0.391	-0.676	3.771	0.688
126	BU2	70177	614053	35	1	150	30	3.25	0.652	-0.886	2.785	0.741
127	BU2	70177	614053	35	1	150	10	3.50	0.328	-0.411	-0.251	2.183
128	BU2	70177	614062	40	3	151	30	2.89	0.814	-0.301	-1.287	0.799
129	BU2	70177	614062	40	3	151	10	3.31	0.534	-0.842	2.986	0.982
130	BU2	70177	614063	70	3	155	30	3.31	0.617	-0.756	2.113	0.837
131	BU2	70177	614063	70	3	155	10	3.26	0.674	-0.864	3.175	1.248
132	BU2	70177	614082	25	3	140	10	3.27	0.690	-0.621	0.453	1.073
133	BU2	70177	614083	53	3	150	30	3.34	0.442	-0.736	2.220	0.856
134	BU2	70177	614083	53	3	150	10	3.39	0.247	0.216	-0.412	2.575
135	BU2	70177	614081	80	3	160	60	3.47	0.257	-0.265	-0.434	0.816
136	BU2	70177	614081	80	3	160	30	3.35	0.558	-1.632	13.513	1.034
137	BU2	70177	614081	80	3	160	10	3.39	0.643	-1.614	11.344	1.587
138	BU2	70177	614092	40	1	150	30	3.27	0.397	-0.238	1.175	1.706
139	BU2	70177	614092	40	1	150	10	3.21	0.770	-0.905	3.265	2.435

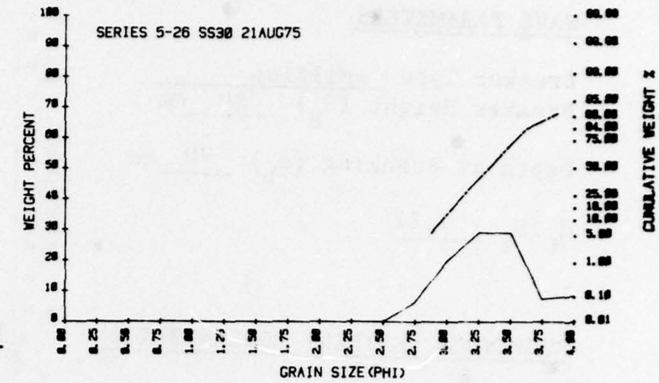
WAVE PARAMETERS

Breaker Type spilling

Breaker Height (H_b) 25 cm

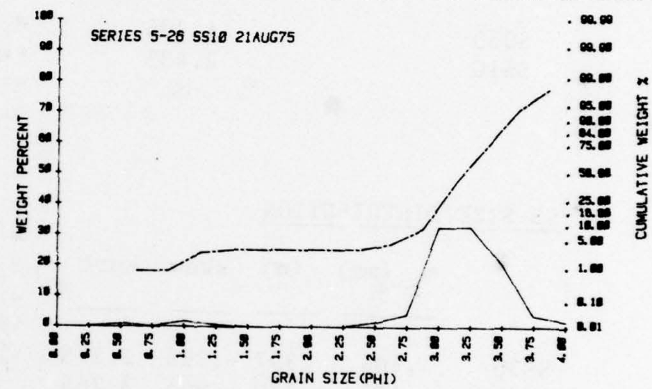
Depth at Breaking (d_b) 30 cm

d_b/H_b 1.2



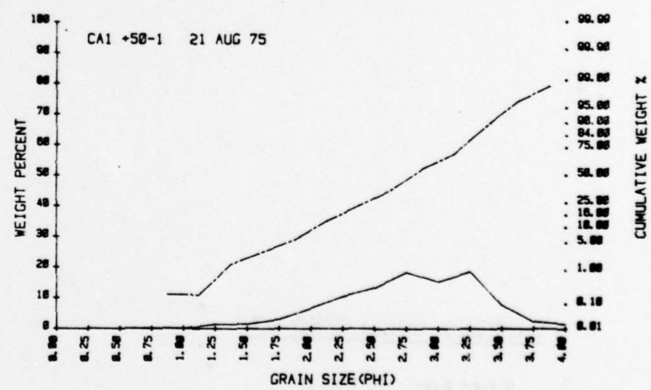
SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS30	.583
SS10	1.513



SS SIZE DISTRIBUTION

	m_z (mm)	(σ) (phi)	skew	kurt
SS30	.099	.323	.137	
SS10	.113	.493	-1.507	
BED	.143	.710	-0.328	.514



SAMPLES COLLECTED AT

Station CA-1

Date 21 Aug. 75

Time 1045

SUSPENDED SEDIMENT SIZE DISTRIBUTION

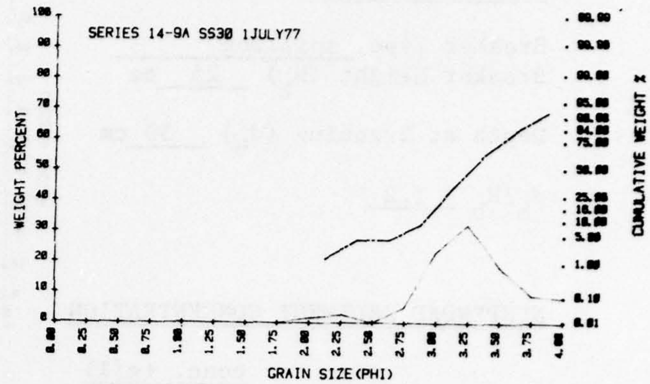
WAVE PARAMETERS

Breaker Type spilling

Breaker Height (H_b) 80 cm

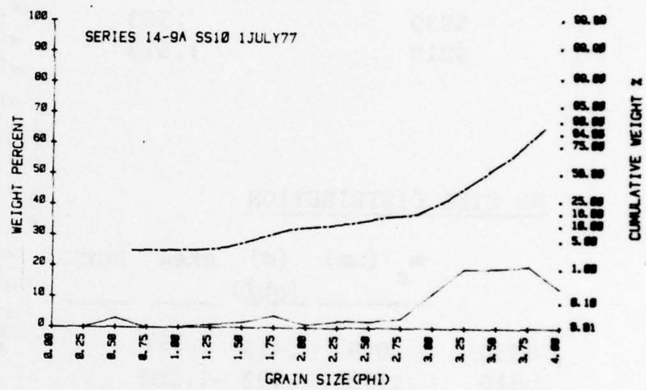
Depth at Breaking (d_b) 90 cm

d_b/H_b 1.12



SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS30	1.706
SS10	2.435



SS SIZE DISTRIBUTION

	m_z (mm)	(σ)	skew	kurt
SS30	.104	.397	-.238	1.175
SS10	.107	.770	-.905	3.265

SAMPLES COLLECTED AT

Station BU-2

Date 1 July 77

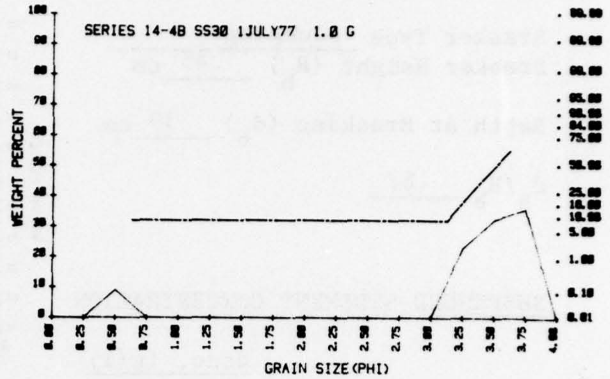
Time 1422

WAVE PARAMETERS

Breaker Type transition
Breaker Height (H_b) 90 cm

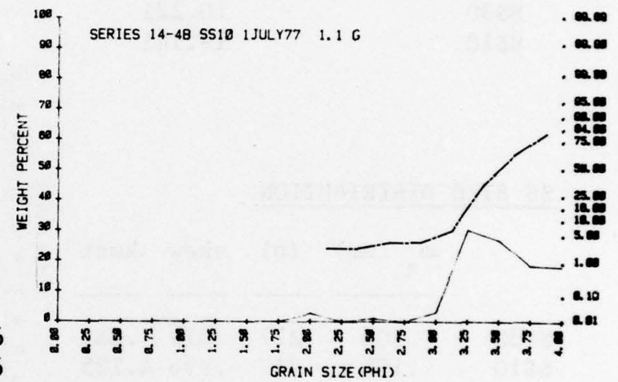
Depth at Breaking (d_b) 90 cm

d_b/H_b 1.00



SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS30	.555
SS10	.688



SS SIZE DISTRIBUTION

	m_z (mm)	(σ)	skew	kurt
SS30	.104	.889	-1.317	.596
SS10	.089	.391	-0.676	1.806

SAMPLES COLLECTED AT

Station BU-2

Date 1 July 1977

Time 1220

SUSPENDED SEDIMENT SIZE DISTRIBUTION

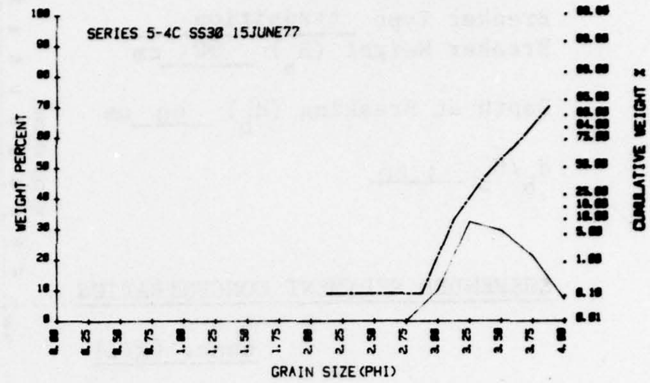
WAVE PARAMETERS

Breaker Type plunging

Breaker Height (H_b) 45 cm

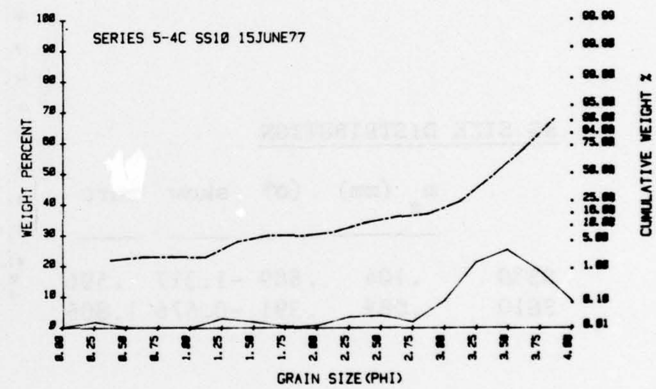
Depth at Breaking (d_b) 30 cm

d_b/H_b .67



SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS30	10.221
SS10	19.161



SS SIZE DISTRIBUTION

	m_z (mm)	(σ)	skew	kurt
SS30	.108	.277	.019	.063
SS10	.105	.747	-.996	4.225

SAMPLES COLLECTED AT

Station BU-2

Date 15 June 1977

Time 1150

WAVE PARAMETERS

Breaker Type non-breaking
Breaker Height (H_b) 50 cm

Depth at Breaking (d_b) .40 cm

d_b/H_b .80

SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS30	.275
SS10	.528

SS SIZE DISTRIBUTION

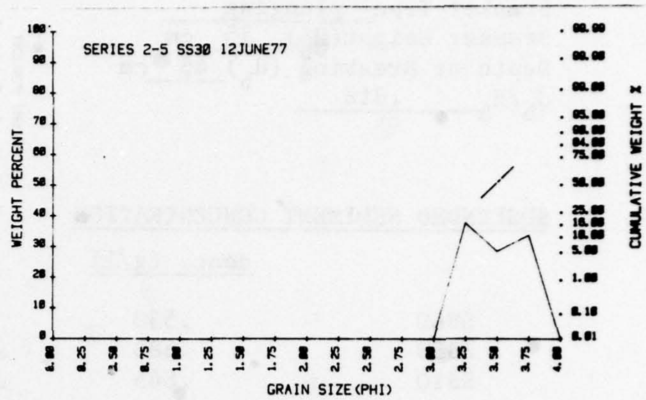
	m_z (mm)	(σ)	skew	kurt
SS30	.089	.211	.038	-1.594
SS10	.095	.398	-.380	.336

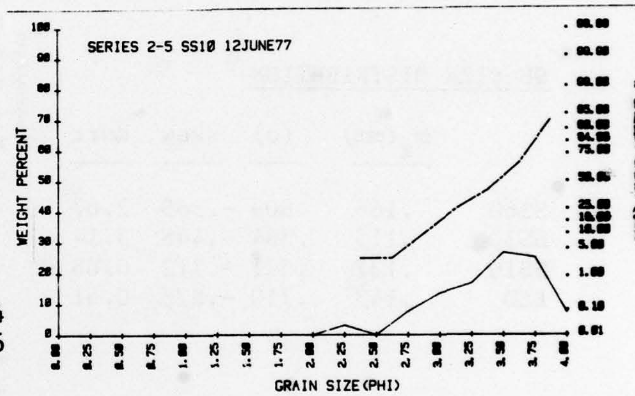
SAMPLES COLLECTED AT

Station BU-2

Date 12 June 1977

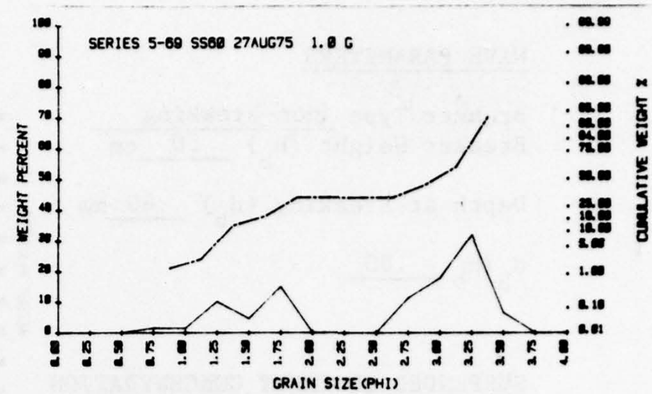
Time 1240





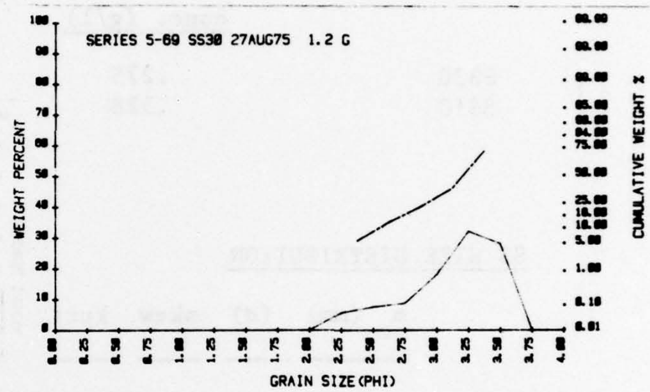
WAVE PARAMETERS

Breaker Type plunging
Breaker Height(H_b) 55 cm
Depth at Breaking (d_b) 45 cm
d_b/H_b .818



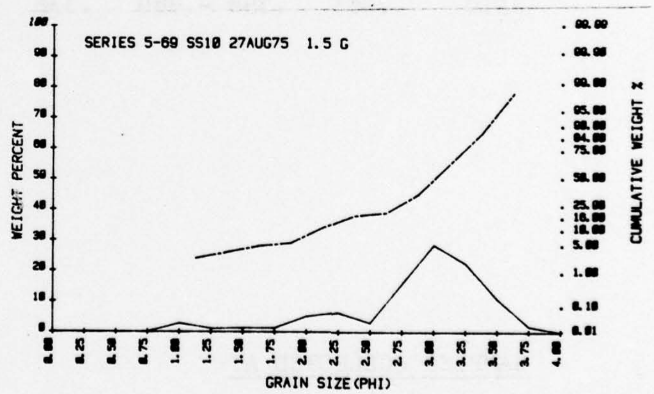
SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS60	.530
SS30	.683
SS10	.845



SS SIZE DISTRIBUTION

	m_z(mm)	(σ)	skew	kurt
SS60	.166	.809	-.365	2.67
SS30	.115	.364	-.448	3.14
SS10	.137	.571	-.712	0.88
BED	.143	.710	-.328	0.51

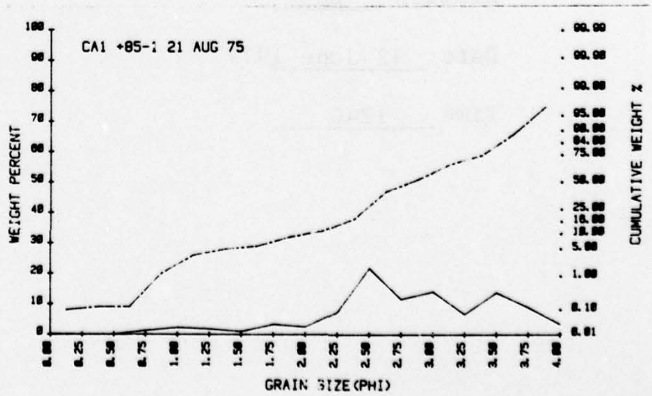


SAMPLES COLLECTED AT

Station CA1

Date 27 Aug 75

Time 1045

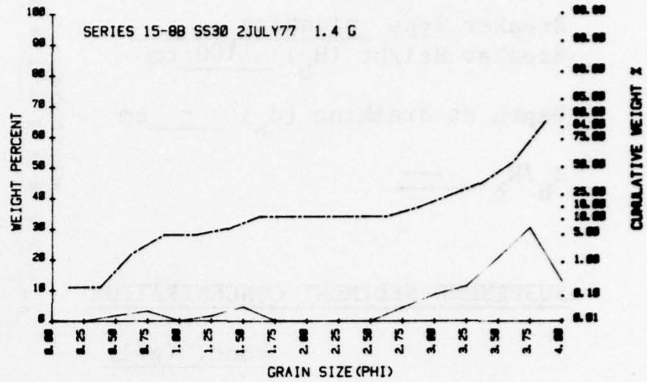


WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 65 cm

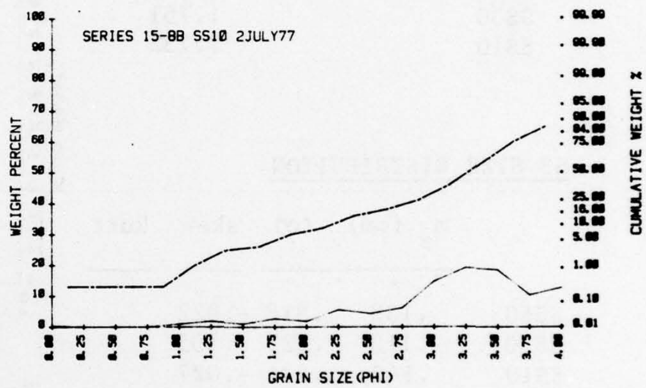
Depth at Breaking (d_b) 40 cm

d_b/H_b .62



SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS30	.738
SS10	3.036



SS SIZE DISTRIBUTION

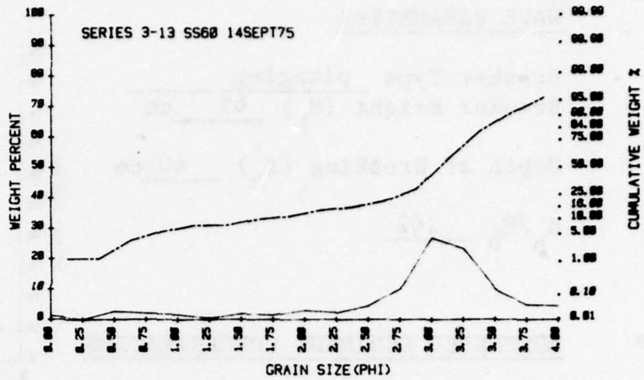
	m_z (mm)	(σ)	skew	kurt
SS30	.105	.864	-.969	2.428
SS10	.113	.687	-.600	.930

SAMPLES COLLECTED AT

Station CA-1

Date 2 July 1977

Time 1409

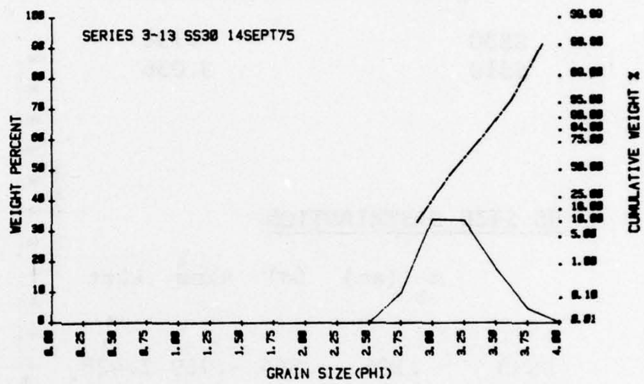


WAVE PARAMETERS

Breaker Type plunging
Breaker Height (H_b) 100 cm

Depth at Breaking (d_b) - cm

d_b/H_b ---

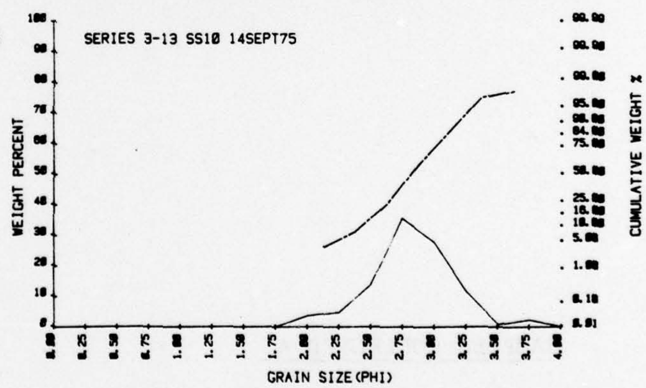


SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS60	1.539
SS30	1.751
SS10	7.732

SS SIZE DISTRIBUTION

	m_z (mm)	(σ)	skew	kurt
SS60	.138	.818	-.822	
SS30	.110	.225	.135	
SS10	.142	.331	-.027	
BED	.190	.940	-.076	-.363

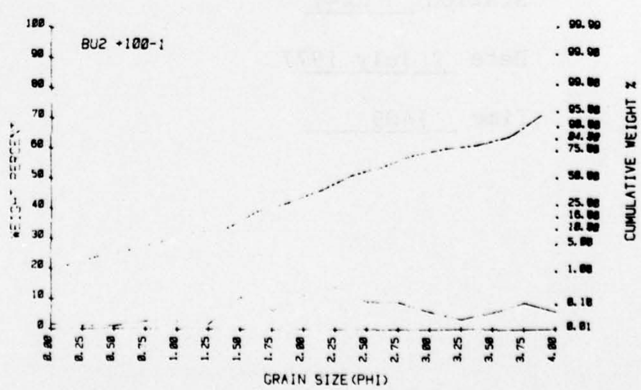


SAMPLES COLLECTED AT

Station BU-2

Date 14 Sept. 75

Time 0955



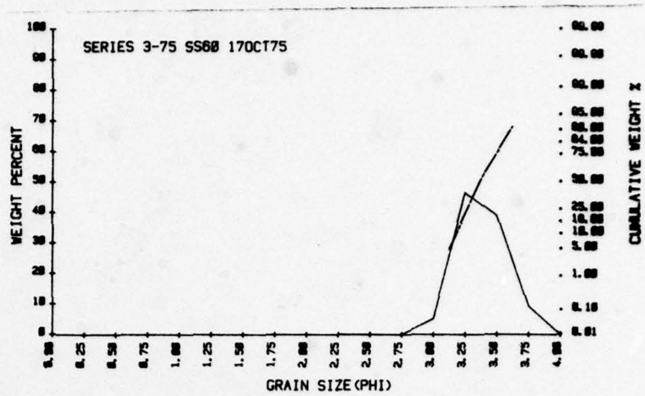
WAVE PARAMETERS

Breaker Type ____________

Breaker Height (H_b) 135 cm

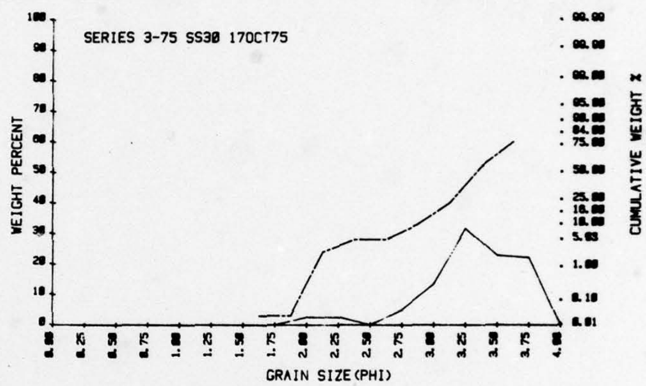
Depth at Breaking (d_b) 130 cm

d_b/H_b .96



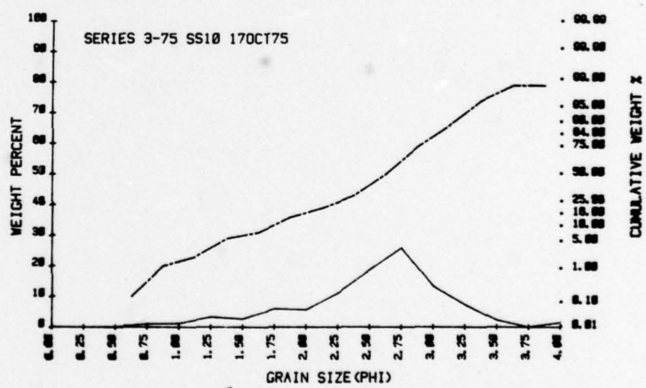
SUSPENDED SEDIMENT CONCENTRATION

	conc. (g/l)
SS60	1.285
SS30	1.592
SS10	11.334



SS SIZE DISTRIBUTION

	m_z (mm)	(σ)	skew	kurt
SS60	.096	.183	.112	
SS30	.101	.392	-.645	
SS10	.174	.586	-.327	
BED	.135	.745	-.781	2.58

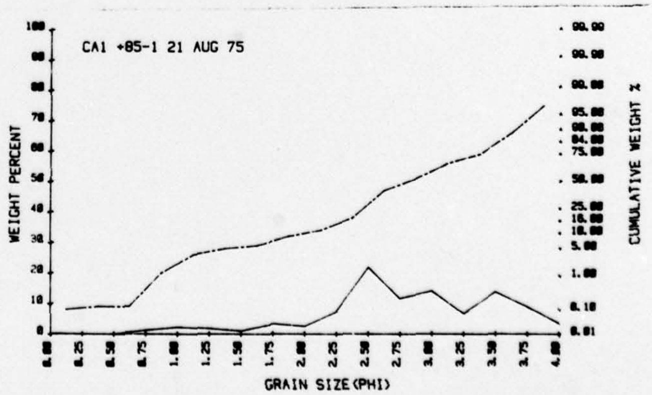


SAMPLES COLLECTED AT

Station CA-1

Date 17 Oct. 75

Time 1500



APPENDIX D - Correlation Coefficients - Suspended Sediment Data

NAME	LGSS10	LGSS30	LGSS60	LGSS100	SSIO	BRKTYPE	D_OVERHB	WVHT	WVDPTH
MEAN	-0.422	-0.687	-1.060	-1.2366	0.726	0.899	0.967	78.517	74.816
STD	0.451	0.427	0.404	0.2533	1.068	0.178	0.179	24.221	23.876
N	405.000	343.000	175.000	11.0000	405.000	408.000	408.000	408.000	409.000
LGSS10	1.000	0.809	0.571	0.3473	0.799	-0.544	-0.535	-0.074	-0.334
LGSS30	0.809	1.000	0.722	0.4243	0.653	-0.532	-0.518	-0.075	-0.329
LGSS60	0.571	0.722	1.000	0.7838	0.395	-0.496	-0.483	0.243	-0.003
LGSS100	0.347	0.424	0.784	1.0000	0.200	-0.083	-0.125	-0.044	-0.087
SSIO	0.799	0.653	0.395	0.2003	1.000	-0.468	-0.460	-0.058	-0.291
BRKTYPE	-0.544	-0.532	-0.496	-0.0633	-0.468	1.000	0.984	-0.247	0.196
D_OVERHB	-0.535	-0.518	-0.483	-0.1253	-0.460	0.984	1.000	-0.251	0.194
WVHT	-0.074	-0.075	0.243	-0.0436	-0.058	-0.247	-0.251	1.000	0.887
WVDPTH	-0.334	-0.329	-0.003	-0.0874	-0.291	0.196	0.194	0.887	1.000
MOFF	0.261	0.279	0.242	-0.2188	0.244	-0.424	-0.261	0.056	-0.092
SAMSLOPE	0.161	0.135	0.204	-0.0850	0.142	-0.185	-0.106	0.045	-0.006
PER	0.106	0.087	-0.205	-0.2219	0.082	-0.139	-0.159	-0.051	-0.171
LSCUR	0.108	0.096	0.385	-0.0028	0.107	-0.065	-0.047	0.202	0.180
WINDVEL	-0.106	-0.070	-0.021	0.3790	-0.040	0.291	0.343	-0.033	0.139
BB	-0.150	-0.208	0.069	0.1212	-0.158	0.244	0.143	0.280	0.384
MF4	-0.257	-0.277	-0.239	0.2157	-0.241	0.423	0.260	-0.058	0.089
BORATIO	-0.334	-0.329	-0.239	-0.0737	-0.284	0.554	0.521	-0.208	0.069
DATE	0.019	0.069	0.277	0.4236	-0.035	-0.173	-0.141	0.584	0.518
SAMTIME	0.153	0.152	0.250	0.0000	0.146	-0.175	-0.166	0.094	-0.001

NAME	MOFF	SAMSLOPE	PER	LSCUR	WINDVEL	BB	MF4	BORATIO	DATE	SAMTIME
MEAN	0.019	0.017	7.151	22.142	7.922	0.141	0.928	1.475	64739.8	1.743
STD	0.009	0.010	1.596	15.762	3.801	0.149	0.034	0.680	4061.5	0.650
N	408.000	408.000	408.000	408.000	408.000	408.000	408.000	372.000	408.0	408.000
LGSS10	0.261	0.161	0.106	0.108	-0.106	-0.150	-0.257	-0.334	0.0	0.153
LGSS30	0.279	0.135	0.087	0.098	-0.070	-0.208	-0.277	-0.329	0.1	0.152
LGSS60	0.242	0.204	-0.205	0.385	-0.021	0.069	-0.239	-0.239	0.3	0.250
LGSS100	-0.219	-0.085	-0.222	-0.003	0.379	0.121	0.216	-0.074	0.4	0.000
SSIO	0.244	0.142	0.082	0.107	-0.040	-0.158	-0.241	-0.284	-0.0	0.146
BRKTYPE	-0.424	-0.185	-0.139	-0.065	0.291	0.244	0.423	0.554	-0.2	-0.175
D_OVERHB	-0.261	-0.106	-0.159	-0.047	0.343	0.143	0.260	0.521	-0.1	-0.165
WVHT	0.056	0.045	-0.051	0.202	-0.033	0.280	-0.058	-0.208	0.6	0.094
WVDPTH	-0.092	-0.006	-0.171	0.180	0.139	0.384	0.089	0.069	0.5	-0.001
MOFF	1.000	0.503	-0.031	0.115	0.101	-0.580	-1.000	-0.353	0.2	0.118
SAMSLOPE	0.508	1.000	0.010	0.049	0.138	-0.227	-0.506	-0.028	0.2	-0.036
PER	-0.031	0.010	1.000	-0.339	-0.490	-0.319	0.032	-0.113	0.1	0.090
LSCUR	0.115	0.049	-0.339	1.000	0.539	0.177	-0.114	-0.021	0.1	0.088
WINDVEL	0.101	0.138	-0.490	0.539	1.000	0.174	-0.179	0.154	0.0	-0.052
BB	-0.580	-0.227	-0.319	0.177	0.174	1.000	0.586	0.250	0.1	-0.050
MF4	-1.000	-0.506	0.032	-0.114	-0.179	0.586	1.000	0.354	-0.2	-0.118
BORATIO	-0.353	-0.028	-0.113	-0.021	0.154	0.250	0.354	1.000	-0.3	-0.148
DATE	0.236	0.166	0.060	0.092	0.011	0.096	-0.236	-0.328	1.0	0.292
SAMTIME	0.118	-0.036	0.098	0.088	-0.052	-0.050	-0.118	-0.148	0.2	1.000